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ENGINEERS AND OFFICIALS;

AN HISTORICAL SKETCH-

OF

THE PROGRESS OF

“HEALTH OF TOWNS WORKS”

(BETWEEN 1838 AND 1856)

IN LONDON AND THE PROVINCES.

With Biographical Notes

ON

LORD PALMERSTON.
THE EARL OF SHAFTESBURY.
LORD EBRINGTON.

EDWIN CHADWICK, C.B.
F. O. WARD.
JOHN THWAITES.

LONDON:
EDWARD STANFORD, 6, CHARING CROSS.

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INTRODUCTORY CHAPTER.

THE REVERSE OF WRONG FALLACY—RAILWAY COMMISSIONERS—ADMIRALTY INSPECTORS—BOARD OF HEALTH CLAIMS.

PACK-HORSES, mail-coaches, ancient Dogberries, water-carts, link-boys, sedans, small-swords, bag-wigs, highwaymen, oil-lamps, and four-bottle legislators, are out of date, and with them the laws and institutions framed for the dangerous days in which they flourished.

The school of stand-stillism—the intermediate school between active despotism and active reform—which worshipped abuses as Indians worship idols, the more hideous the more reverently—flourished under Lord Chancellor Eldon, and expired with Colonel Sibthorp.

We are all reformers now! The wholesale questions—the battles for the free speech, free press, free gospel, and free trade, are settled, and “Whig or Tory bred,” whoever wishes to cultivate a small field of popularity and political success, looks out for a waste to be drained and subsoiled, ploughed, harrowed, and cropped in the most approved style of modern legislative reform: one takes education, another criminals, a third coalheavers, a fourth sailors under his parliamentary charge; and it would seem as if a

considerable number of people were beginning to believe that the men who have made old England what she is, live, not on bread and beef, earned by industry, but on Acts of Parliament, with the help of official Commissioners; that no one is now capable of taking care of himself; that every community requires the horn-book and rod of a salaried professor, like he of the Black Rod who starved the Governor of Barataria, to save him from indigestion.

From that apathy that let the representatives of deserted towns rule the nation, and descendants of a small clique hold all municipal authority—from that apathy that permitted death to be the penalty for stealing a yard of calico, and left the safety of life and property dependent on superannuated Dogberries, we have rushed into the opposite extreme—tying up the originality, the private enterprise, the self-dependence that distinguish us from our spoon-fed Teuton neighbours, by exchanging the great “LET-ALONE” principle for OVER LEGISLATION, and aggravating “OVER LEGISLATION” by “IGNORANT ADMINISTRATION.” In a word, the favourite fallacy of the day is not fear of the mob or the monarch, but “*the reverse of wrong fallacy.*” Afraid of gout, we make sure of paralysis.

Englishmen are not Prussians, and certainly English officials are not German professors.

In Prussia, the State absorbs all the choice talent of the day. According to the Prussian system of education, everybody is educated to be fit for everything. On completing his university curriculum, the first prizeman has learned the rudiments of every science,

of every art, and is equally prepared to become a professor or a captain of military engineers, superintendent of a Government manufactory, a Government railroad, or of a Government dockyard ; so well prepared that the chances are that in the whole course of his official life he never meets with a man out of Government employ better informed in his own special department than himself. The consequence of this system is, that the Government may be admirably and economically served by first-rate men, but the nation at large mentally emasculated—barren of private ambition or private enterprise—jogs on, contented to walk in leading strings, be fed with a spoon, smoke, read, muse, drink, and dance, except an unhappy few, who, disgusted at finding no free opening for their ambition and genius, madly rush into socialism or some other foolish *-ism*, ending in a prison or exile.

Now, in England, to begin at the beginning, we have no stock to draw upon for filling up the army of bureaucrats, which it seems the special object of recent minor legislation to create ; so that when it is settled by Parliamentary wisdom that some trade or work wants regulating, the chances are ten to one that the Board or Commission selected to become the King Stork has to learn the rudiments of the business it is about to rule. To compensate for the general ignorance of English bureaucrats, the system of Blue Book Reports has been invented and brought to perfection.

Let us take as an instance a case of “cream tarts.” An M.P. of influence on his way to the House, steps

into a pastrycook's and eats a cream-tart; he thinks it detestable; he has an indigestion, consults his friends, and finds from their report a general deterioration in the character of cream tarts; thereupon, with the aid of a persevering and briefless barrister, a correspondent of the "Weekly Acidulator," he founds a private association for the Reform of the Cream Tart Manufactory. The association includes, besides the lawyers who swarm round festering jobs like flies in a butcher's shop, men of science in search of reputation, doctors in search of patients or a place, and is gilded by a suckling lord or two, not strong enough for real political life. The society gets up petitions and manufactures paragraphs, holds meetings, has dinners, abuses the pastrycooks and dairymen, and praises itself. Parliament catches the infection, and the idea of obtaining tarts equal to those described in the Arabian Nights, forms a staple of conversation for all the bores in the House. The Minister who at first pooh-poohed the question, finding some near and troublesome connection among the cream tartites, takes the petition into consideration, and promises to introduce a measure. At one time there are plans prepared in Whitehall for a Government Cream Tart Manufactory, but the country not being continentalised quite up to that degree, the idea is given up in favour of a Commission—the Cream Tart Commission, consisting of a president and two commissioners, secretary, assistant secretary, law clerk, physician, chemist, stove engineer, and staff of clerks. When the bill of these salaries is introduced in a

thin house, at the end of a weary session, the only opposition is from an M.P. not connected with the Temple, or the Minister, who admits that the cream tarts were bad a year back, but suggests that since the agitation of the Cream Tart Reform Society a great improvement has taken place ; in fact, that cream tarts are now excellent, and that in any case it would be sufficient to appoint one inspecting pastrycook for the metropolis. Of course, his opposition goes for nothing, the appointments are all made ! Lord Libbington extinguishes the Anti-Tart M.P. by a technical lecture on the tart manufacture. The Bill becomes an Act, and a small band of lords, lawyers, and doctors, perfectly innocent of the art of pastry, take their seats and their salaries, and proceed to regulate the confectioners of England. In due time a report appears, fluently written and neatly printed. It contains the history of cream tarts from the time of Mahomet to Chadwick—the statistics of their consumption ; an analysis of their contents by the Board's chemist ; a dissertation on the comparative value of the cream of the Yorkshire, the Dutch, the Alderney, and the Ayrshire cow ; a statement of the immense ameliorations, with extracts of evidence, produced by the labours of the Board ; and in an appendix, a copy of correspondence with the tart makers, and a letter from a special commissioner deputed to visit, taste, and report on all cream tart shops between Calais and Vienna.

When this "elaborate, curious, and most valuable report" is laid on the table of the House of Com-

mons, with an appropriate speech from Libbington, the second year's salary is voted as a matter of course; for the Board, though it could not manufacture a single cream tart, has succeeded in manufacturing an admirable Blue Book!

It is the instinct of Controlling Boards to seek to absorb and centralise far more detailed power than they can usefully exercise. So they write letters without end, and issue orders without stint. It is their weakness, unless checked by public opinion, to meddle with everything, object to everything, and finish nothing.

"The hood," says a mediæval proverb, "does not make the monk." But the British official of the nineteenth century often seems to consider that his office has clothed him with science, experience, and every other qualification for ruling over practical men and practical work.

Since 1831 we have had many Commissions and tons of Reports; but the results, as compared with volumes and the salaries, have been of the smallest when not most mischievous.

We have not space here to show the extravagance and laches of the Charity Commission; the many instances of over-meddling and useless interference of the Poor Law Board (a very useful Board, yet like all such Boards too greedy of power). The first Board of Health we have dissected in the body of this work, but we will give a few examples of "over legislation" from the records of railways, and from the proceedings of Admiralty Inspectors.

The railways of this country have grown up without the aid and in spite of the obstructions of officiality in every shape. Landowners and lawyers (representing, directly or indirectly, at least half the British Parliament) have made fortunes, paid off mortgages, obtained bridges and roads, drained and added fifty per cent. of value to their estates at the expense of railroad shareholders, competition has been encouraged, and every third-rate town has been supplied with from one to three lines. By the greed of legislating landowners, and the competing theory of Parliament, fares have been increased, and the dividends of shareholders severely mulcted. What the nation has gained by the rapidity with which the country was intersected with locomotive roads, while the continental governments were still deliberating on the best possible route, it would be impossible to estimate in money.

Yet from time to time we hear the law-making class grumbling that travelling in high-waged England is not as cheap as on the Continent, where Government assistance, cheap land, monopoly of railroad communication, absence of local taxation, and accommodation in daily trains *below* the demand, are among the benefits enjoyed by the companies. A Government organ lately went further, and suggested, in the face of Admiralty gun-boats and Balaklava blunders, that a Board with a peer for president, and an army of Sappers and Miners, would have given the country a better system of railways than it now enjoys. These are brave words ; but let us turn to

facts, and measure, in forgotten reports, the capacity of the officials whom our Government delights to honour.

An early specimen of the incompetence of Government officials as referees or arbitrators on questions arising out of great public works was afforded so far back as 1837, when at the request of the House of Commons a military engineer was appointed to arbitrate on four competing lines projected between Brighton and the metropolis. The engineer selected was Captain Alderson, afterwards unfavourably known as a Commissioner of Metropolitan Sewers. Captain Alderson made his award in favour of what was called the Direct Line against the Western Line, although he had "no hesitation in asserting that in an engineering point of view the Western Line was preferable to any other." Unfortunately for his reputation he gave his reasons for selecting the Direct Line in spite of engineering difficulties—nineteen years have tested those reasons, and shown what sort of railway arrangements would have been made had the official party succeeded in superseding private enterprise by public works under the control of military engineers.

Captain Alderson reported that the Western Line, "avoiding heavy cuttings by following the valleys of the rivers Mole and Adurn, accommodated Epsom, Dorking, and Horsham on its main trunk, and arrived at Brighton *via* Shoreham, with no heavy work, except two short tunnels at Dorking and Epsom."

The official arbitrator chose the straight and

costly line for several reasons, one of them more than ordinarily absurd.

He considered the traffic of Epsom, Dorking, and Horsham "too insignificant to require railway accommodation." Since the execution of the main line it has been found necessary to make branch lines to Epsom, Dorking, and Horsham, at a cost for making and working which would make a handsome addition to the annual dividend. He considered that the railroad *should not touch Shoreham* (that being so far on the road to Worthing) before it reached Brighton, because, in his own words, "*A railroad touching the coast before it reaches Brighton might transfer the advantage of position to another place, and sooner or later prove injurious to the property at Brighton!*"

After indulging in various engineering estimates which were all untrue, and making use of theoretical tables which he in another place admitted did not apply, he compared the length of the competing lines; and made two errors, one of $20\frac{1}{2}$ miles, and the other of $7\frac{1}{2}$, *both errors being in favour of the line he recommended!* So much for the first official railway arbitrator.

Some years afterwards the Railway Board was appointed; that Board broke down in a plan for turning railways into a Government property and institution, but it still exists under the pretence of "inspecting railroads," and protecting the public against the rashness of civil engineers, and the cupidity of railway directors. A succession of military engineers have held office in this Board—

have inspected lines, issued rules, and granted certificates, without having anything but a most superficial knowledge of the works they professed to control.

We do not mean to assert that the idea of tightening the responsibility of engineers and railway directors was not theoretically sound, or that there might not have been advantages from a competent authority, with power to arbitrate or mediate between competing lines; but we shall show that railway inspection has been a sham, because the railway inspectors have from first to last, from Burgoyne to Wynne, had no qualifications for their task, except always the official authority in which they were clothed. In fact, they have always been wholly wanting in those practical and scientific qualifications, which could alone enable them to understand what they saw, or foresee what ought to be done.

A recent and ridiculous example of the value of official opinions on questions of civil engineering is to be found in a report made to the Board of Trade, upon the condition of the Yarmouth and Lowestoft Branches of the Norfolk Railway, dated 21st February, 1856. In this, the second of two documents of the same character, Colonel Wynne makes a most alarming report on the condition of a line, on which neither previously nor subsequently has any accident occurred; and on which he incidentally acknowledged the needful repairs were in course of regular execution; but with a rash presumption that seems incident to official authority, he went out of the way to assert, that the wooden bridges and viaducts being

“in a dangerous state of decay,” “*wood can not be considered a safe material for railway structures.*”

This brought forth a letter from the well-known engineer, Mr. G. P. Bidder, who, fortunately for the public, spoke out plainly, and did something towards exposing, if not extinguishing, one official sham. He began by observing,—

“Iron girders have occasionally failed—brick arches have broken down—earth embankments have settled—cuttings have slipped and turned trains off the line—tunnels have fallen in,—various accidents, from failure of brick-work, earth-work, and iron-work, have occurred on railways, but I believe that no one can point to an instance in which an accident has been shown to arise from simple failure of timber.

“Experience, therefore, is opposed to the conclusion of the Government Officer. But timber works are as safe as any other class of works for railways, because they are more easily capable of inspection. In an iron casting there may be a flaw, which the most experienced person may be unable to detect; an earthwork may be started by some action of the elements, against which no one can provide; no one can see into brick-work; but with timber, when it commences to decay, as decay it will, like everything else, that decay is easily detectable.

“Reason teaches, also, that timber is more readily capable than other material of simple, cheap, and perfect restoration. If a beam or sleeper proves to be unsound, all that is needful is to replace that single beam or sleeper. Hence, no doubt, the reason

why timber is so generally adopted upon railways as the basis of the fabric. Nearly every railway rests upon a timber foundation, inasmuch as the rails rest on wooden sleepers. All such wooden sleepers are liable to perish, yet they are in all but universal use."

It comes to this then: Either the civil engineers of England are wrong in their observations, experience, and practice, or the military official engineer does not understand the elements of the business he is supposed to supervise.

In another paragraph Colonel Wynne says:—"The progress of decay in timber is so rapid, that by the time all the lines, on some 400 or 500 miles of railway, have been temporarily secured, it will be time to go over them all again,"—a fact which, far from being a danger, is a positive protection to the public; for when repairs are constantly going on, when it is known that timbers will not last more than fourteen years, attention is constantly directed to the repair of the works, and the vigilance of the parties answerable for the safety of the line is not lulled to sleep by false confidence in the unlimited durability of any material.

As if determined to destroy all confidence in official inspection, the unfortunate Colonel does not make one statement, or give one opinion, that he does not contradict, or upset, in some ensuing paragraph.

He crowns his work, after raising the alarms of the ignorant to the highest pitch, by reporting that—"When I inspected the repairs the bridge was

undergoing, they were nearly completed, and were such as *to put the structure in perfect security* ;” these repairs having been undertaken under the orders of the engineer of the line, previous to, and quite irrespective of, the official survey and report.

A crowd of instances might be cited to show that official inspectors wanting in daily personal, active, practical experience, are quite incapable of deciding on the efficiency or inefficiency of public works.

“In 1849 the Government Inspector reported to the Railway Department of the Board of Trade, that the Torksey viaduct and bridge over the river Trent, on the Manchester, Sheffield, and Lincolnshire line of railway, was insecure, and ‘could not be opened with safety to the public.’ The Government Inspector required additions to be made to its strength, which the Engineer of the railway declared to be unnecessary, and which he refused to recommend the Railway Company to make. After three months’ correspondence and delay, the Board of Trade consented to certain experiments being tried before the Government Inspectors, in order to ascertain the strength of the bridge. These experiments took place on the 28th March, 1850; and on the 6th of April the Board of Trade informed the Directors of the line, that they had ‘reconsidered’ the propriety of allowing the line to be opened, and were willing to allow it to be used. It has been used from that day to the present time without a single accident,—thus demonstrating that it is not ‘inspection’

but 'experience' that alone can demonstrate what is strength and what is weakness."

"In the same way, the Railway Department of the Board of Trade refused, on the report of their Inspector, to allow the opening of the line from Waterloo Station to Vauxhall on the South Western Railway, on account of the assumed insufficient strength of the bridge which spans the Westminster Road. After considerable delay, the line was allowed to be used, without the bridge being strengthened. The whole traffic of the line has ever since passed across that bridge without a single accident or threat of one.

"These facts and instances illustrate the conclusion, that in reporting the bridges and viaducts of the Eastern Counties Railway as in 'a dangerous state of decay,' and in laying down the principle that wood cannot be considered 'a safe material for railway structures,' Lieutenant-Colonel Wynne has embodied in an official Report statements which neither experience nor reason justify. And they further appear to indicate, that the Railway Department of the Board of Trade is in the habit of receiving from its Inspectors reports and representations of a character calculated to excite needless alarms; and that it is also in the habit of assuming, upon those Reports, a false position, from which, sooner or later, it is obliged to recede."

The tendency of Official Engineers to exercise an ignorant despotism over their superiors in practice, and equals, at least, in theory, is not confined to

England. In France the Government corps of Engineers whose railways were remarkable for their costliness, threw every possible impediment in the way of private enterprise. Among other instances, they reported against the safety of one of Mr. Locke's bridges on the Paris and Rouen line. Mr. Locke stood firm. The Official Engineers proceeded to try what it amounted to, whether they could crush the bridge down, for after sending across trains loaded to an extent that no train ever will be loaded, they actually covered the bridge with wet sand, but the bridge would not fall, and the Civil Engineer beat the Official Engineers.

Mr. Bidder's concluding argument against one of the many official shams, founded on the "Reverse of wrong fallacy," which philosophical reformers have been so industrious in manufacturing within the last twenty years, is too good to be omitted, as it applies to other beside railway works. He says :—

"In order to inquire and report satisfactorily respecting a railway, it is necessary that the inspectors should be persons of enlarged experience, accustomed, not only to the construction of railways, but to their daily use. In the present, and in other cases, the reports to the Board of Trade upon Railways, their working, and their condition, have been made by a gentleman who has never himself been engaged in the construction of a single mile of railway or of a single bridge, who practically knows nothing about either, and whose only source of practical acquaintance with the subject on which he so strongly reports,

is that practice of inspection, of new railways, which, for all useful purposes, every civil engineer knows to be valueless and absurd. With a host of eminent officers of engineers employed in the Crimea, her Majesty's Government, nevertheless, thought it proper to entrust practical Civil Engineers (the principal of whom was engaged in the construction of your line) with the duty of laying down six miles of railway from Balaklava to the heights: it certainly does appear not a little anomalous that that Government should think it proper to commit the inspection of the railway works of practical Civil Engineers to men of the very class to whom they could not commit their construction!"

Our next instance of a species of official despotism which is growing up under the special patronage of our philosophical radicals is to be found in the records of the Admiralty. The Admiralty, exercising the indefeasible rights of the Crown, is the imaginary trustee of our rivers, sea shores, and natural harbours.

It is self-evident that some competent authority should be exercised to protect the interests of the public against the encroachments of private enterprise, and to take care that future capabilities are not sacrificed to present temporary advantage.

That is the theory of paternal government; the practice is, to commence by throwing every impediment in the way of turning a mud flat into a dock, a petty fishing village into a good port, or substituting a bridge for a ferry-boat, and to end by extracting, in

the misused name of the Queen, a heavy compensation for transforming worthless waste into valuable building land. Thus private enterprise is checked, and engineers of the first class are pestered to swell the importance of Admiralty officials ignorant of the first principles of the profession they presume to regulate and control.

When, in 1848, railway extensions had rapidly multiplied the applications to the Admiralty for leave to cross navigable rivers, and improve sea-shores, the late Joseph Hume originated an Act for appointing two Admiralty Inspectors or Commissioners to make specific reports on every public work subject to Admiralty decision, instead of leaving such decisions to the result of parliamentary influence or private earwiggling of the First Lord. Here was a correct theory founded on the idea that the Inspectors would be competent men, versed in the science and practice of that branch of civil engineering which they were to inspect. But the usual course was followed. The Admiralty was consistent, and did not shame the Railway Board or the Board of Health by seeking for Inspectors up to the mark of modern civil engineering. One example will be enough.

In 1849, the promoters of a Company for draining and reclaiming land on the Norfolk Coast, and at the same time improving the navigation of the river Ouse and the port of Lynn, came before Parliament for an extension of the time granted them for the execution of their works by an Act obtained in 1846. The plan on which they were proceeding had ori-

ginally been devised (in 1840) by Mr. Rennie and partially carried out. It was enlarged under a new Act in 1846, and consisted mainly in substituting for the circuitous channel which in the course of ages the waters had washed out to the sea, a straight channel of a certain depth and breadth. This plan, prepared by Sir John Rennie, had received the approval in all its main principles and details of Mr. James Walker in 1840, on the part of the Admiralty; of Mr. Rendel, also on behalf of the Admiralty, in 1846; and of Mr. Robert Stephenson, called in by the inhabitants of Lynn; and it was further supported by the fact, that improvements in the river Nene, executed on the same plan, under parallel circumstances, had produced exactly the results required by the engineers. Therefore a parallel precedent, as well as the unanimous opinion of engineers of the greatest experience in such works, testified in favour of a direct straight channel to the sea. However, under the Act of 1848, the works, approved by the Act of 1846, came under the supervision of the Admiralty Inspectors in 1849 — Captain James Vetch, R.E., and Captain John Washington, R.M. The naval captain is presumed to report on matters of seamanship and navigation, the royal engineer to report on engineering details.

The Inspectors went down to King's Lynn in April, 1849, and held an inquiry of two days, respecting the Norfolk Estuary Bill. They examined, beside local witnesses, Sir John Rennie and Mr. Robert Stephenson. The report of the examination, with appendices,

fills 159 folio pages. The Inspectors reported in 20 folio pages, with a coloured map, against the principles and whole plan devised and approved by Rennie, Walker, Rendel, and Stephenson.

The whole report is a mass of misrepresentation, misquotation, ignorance, and absurdity, such as could never have found its way into print under any less powerful influence than that of office. The Inspectors were evidently as innocent of the first rudiments of hydraulic science as devoid of experience in hydraulic practice. We can only spare space for one extract, but that is a plum. The Inspectors, after saying that if they had the power, they would not assent to the execution of the plan sanctioned in 1846, proceed to recommend, instead of a straight channel, the improvement of the circuitous channel of the river, by rounding off some sharp bends, and by confining the concave shore in parts by low rubble walls; and they support a proposition which is plainly absurd to even an agricultural drainer, by saying, "*We believe that in many cases a channel with gentle curves conveys the water faster than a straight channel. Nature has always preferred curved channels for her watercourses to straight ones, and it is but reasonable to assume that there is good cause and physical law why it is so!*"

This was, as the French say, "a little strong."

The Committee of the House of Commons had this Inspectors' Report placed before them by the Admiralty, as their weight in the scale of opposition. The Committee had no power to summon the Inspectors,

and place them under examination and cross-examination, so as to learn "the reason why" of their hydraulic eccentricities; but they considered and treated the Admiralty Report with the contempt it deserved. Sir James Graham was at that time First Lord of the Admiralty. He was appealed to privately to withdraw, as a matter of common justice, the Admiralty opposition, based as it was upon fallacies which his common sense could detect.

Sir James's answer is instructive. It is a lesson for those who permit meddling boards to be created, or ignorant or obstructive officials to be appointed, without appealing to public opinion. It is a key to the defence of Crimean murderous muddles.

Sir James, after hearing the evidence of all the eminent engineers of the day against the roundabout theory, said,—

"We must support our own officers."

That is the official religion!—to support the Government officer, *right or wrong*.

The question came to a fight in the House of Commons. Sir James opposed the bill. He was answered by Mr. Stephenson, who read the "curved channel" paragraph we have quoted. The House, which would probably have been humbugged had a less eminent man opposed the Admiralty, showed that it meant to vote with the engineer against the official; and then Sir James, with his usual well-bred tact, withdrew his objections in a complimentary speech, but characteristically concluded with a mis-statement, by way of excuse for his own previous insolence. He said,—

“Waving to the authority of so eminent an engineer, he would venture to remind Mr. Stephenson that in some instances the greatest improvements had been effected by curved channels,—as, for instance, in the Clyde.”

The forms of the House did not permit a contradiction, but the facts are just the other way. The Clyde was improved by straightening crooked and dredging shallow channels, as much as natural obstacles would permit.

The last attempt to perpetuate and extend a system of centralisation which centralises authority in the hands of the ignorant, and impedes real, useful work by the sham work of “forms,” “orders in council,” and “regulations,” is to be found in a Bill entitled the “Public Health Act Amendment Bill,” prepared and introduced by Sir George Grey, the Home Secretary, and Mr. Cowper, the President of the expiring Board of Health, for the purpose of increasing and rendering perpetual the powers of the present Board of Health.

Under this proposed Act, the Board of Health will be a sort of High Court on health questions and health or sanitary works in all the towns and rural parishes of England, with power to make laws and enforce them; to repeal, consolidate, and amend local Acts of Parliament; to give orders to local engineers and local architects, and even to control the already established Municipal Corporations.

Now it has been usual, before high legislative and judicial powers have been bestowed on any man, that

he should have given some proof of his qualifications ; or at any rate that he should have acquired some reputation in the pursuit over which he claimed to be Dictator and Judge of Appeal. The same rule ought to apply to Boards. Although two negatives may make an affirmative, no number of mediocrities will make a wise Council. In a battle-field, six Lyndhursts would not be equal to one Wellington ; and in a patent case, six Napoleons would not be equal to one Lyndhurst (when Lyndhurst was Copley).

The Board of Health, which claims the extraordinary powers we are about to describe, and which has prepared for itself so large an extent of reporting, corresponding, and printing, does not include one name that inspires respect among the practical men whose works it proposes to regulate.

The Honourable Mr. Cowper is a very proper man for the post of President, provided there is nothing more to be done than present an annual report to the House of Commons. He is amiable, gentlemanly, and the son of Lady Palmerston. If he were content that his office should be an offshoot of the Registrar-General's department, purely admonitory and statistical, ready to give good advice and report progress, there could be no objection to him whatever. The country loses nothing by having minor sinecure posts in which to train the young aristocracy, and keep them out of mischief.

Mr. Tom Taylor, the secretary, is one of the most accomplished literary men of the day, one of Punch's bright particular stars, author of some of the best modern Plays and Farces in fact at all in the

ring, from burlesque ballad to serious comedy. In France, with his talents, if on good terms with the Government, art, literature, or the drama would have found him some honorary post at least equal in salary to that he now enjoys. We do not grudge him his £1000 a-year—he deserves that and more—but we object to his earning it by lending his talents to backing up the ridiculous engineering theories of his old friends the Chadwickians. Mr. Austen is the engineer of the Board, and it is only in that capacity that he is known at all. He may be a very clever man, but he has chosen to endorse all the absurdities of Mr. Chadwick, from three-inch pipes to the sump system with golden guineas from liquid sewage. The plans he has approved have failed. There is not one engineer or architect of the slightest reputation who would or could act with him. So to set him up as the engineering court of appeal, is to proclaim war with two eminently practical and scientific professions. The proposition of the Public Health Amendment Act, having Mr. Austen in view as engineer, is something like proposing a new Court of Appeal to supersede the House of Lords, in which the office of chief judge was to be filled by an Insolvent Court attorney.

The last and best official of the Board of Health is the medical officer, Dr. Simon, a gentleman who thoroughly understands his department, and well deserves his salary. Dr. Simon, as an authority to whose experience the metropolitan and local officers of health could appeal for advice, — to whom the Home Minister, or President of the Board of Health,

could apply to report on any special subject, is a very useful appointment. A medical adviser may be as valuable as a legal, a military, or a naval adviser ; but Dr. Simon, as dictator over the sanitary arrangements of all England, implies the stereotyping of one system and one set of ideas in the arrangements of every locality. Take it for granted that Dr. Simon is superhuman and gently uses his gigantic powers, we must remember, when assenting to the Act that makes him autocrat, that he may be succeeded by a Dr. Andrew Smith.

The first power created by the new Bill is that of inspecting. At present the Board has really nothing to do. If the Board can send an inspector to visit any district for the purpose of inquiry into the execution of the Public Health Act, there will be plenty of inquiries at public expense, plenty of didactic treatises on sanitary questions, plenty of work for the printer, and a long bill annually for Parliament, with a pile of blue books as vouchers.

Has England so little talent of self-government—have public opinion and the press so little power, that it requires a young gentleman from London at £5 5s. a-day (one of the gentlemen who have made such work of Southampton, Dover, Sandgate, and Croydon), to tell provincial towns how to drain and sewer and pave? If it be so, the tribe of candidates for the post of *Official Bagmen* will increase mightily when the Act passes.

Clause X. is evidently framed to give the sine-curists of the Board of Health something more to do,

or, at any rate, the appearance of doing something. The Municipal Council of a borough may adopt the Public Health Act, and if there is any local Act relating to the purposes of the Public Health Act, the Council may pass a resolution calling upon the Central Board of Health to issue a Provisional Order to consolidate or repeal any such local Acts; thereupon the Central Board of Health is to make "*inquiry*," and bring a Bill into Parliament for confirming such order, which is not to have any force until confirmed by Parliament.

This is a fine example of official sham work. It begins with a Municipal Council passing a resolution to adopt the Health Act, so as to supersede various paving, lighting, and sewerage Acts, and it ends with an application to Parliament. Between the resolution and the Act of Parliament, the Central Board steps in and manufactures some official business by an "*inquiry*" and a "*Provisional Order*," which, as it is not to take effect, but to remain a dead letter, until an Act has been passed through Parliament, might just as well be omitted altogether. The Central Board kindly undertakes passing all local Acts, thus securing a little more patronage for its lawyer friends. The Central Board proposes to have the power of setting out wards for the election of Local Boards. Why, the work would be much better done, and at less expense, by a local authority or arbitrator, a surveyor or county magistrate. But, no! there must be more berths for young gentlemen at £5 5s. a-day. Under the Municipal Act local

officers conducted the first elections, but the busy-body Central Board of Health proposes to appoint persons for that purpose; of course, not without inquiry. The Bill ought to be entitled a Bill for increasing the Patronage of the Board of Health.

Clause XXX. creates a fine crop of litigation, with proportional appeals and patronage for the Central Board. No one is to be allowed to build a house in any town, under the Public Health Act, without giving fourteen days' notice, and in such form as the Central Board of Health shall direct, with the following particulars:—1. Thickness and materials of the walls; 2. Heights and dimensions of the rooms; 3. Means of ventilation; 4. Situation of water-closets or cesspools; 5. Provision for drainage, supply of water, and deposit of refuse; 6. Dimensions of the space intended to be left open in connection with the house.

Surveyor of Local Board to have power to inspect, and be entitled to have two days' notice when work is ready for inspection. If any person feels aggrieved with the decision of the Local Board as to any decision in reference to any building, he may *appeal*—not to a local magistrate—not to arbitration—but to the General Board of Health in London.

The theory of securing the best materials, the best dimensions, the best ventilation, the best drainage, and model water-closets in every village of the kingdom is charming, but let us see how it will work.

In a small town in Cornwall, or South Wales, are two builders, architects, and surveyors. The one

(say Jones) is elected surveyor to the Local Board of Health; the other (Jenkins) is employed to build a row of houses—Paradise Row. Jenkins, as in duty bound, sends in his plan; Jones, who is also in practice, and gets only £50 a-year from the Board, objects to Jenkins's plan; perhaps his objections are perfectly honest; perhaps he is not jealous that Paradise Row has not been put in his hands; perhaps he does not wish for an order for stone from his friend and patron, the alderman's stone quarry, instead of compo; at any rate it is the mania of every one to give advice, and the weakness of those who have power to use it, to show they have it. Jones, quite honest, may be an enthusiastic Ruskinite; he may object to compo, or any other sham; his theory of ventilation may include high-pitched roofs; his plan of drainage may depend on tubes of one make, while Jenkins prefers another.

It is just as difficult to deal with an enthusiast as with a rogue. At any rate the chances are that Jones and Jenkins differ about the plan of Paradise Row, and after pressing all their friends in the Board into the dispute, they cannot agree. Then comes a reference—not to the mayor or magistrate living within a mile—not an arbitrator who knows the country, the soil, the climate, the comparative value of brick, stone, compo, chalk lumps, or rough flints—but a reference to the London Board, with correspondence, copies of plans, personal interviews, and finally a surveyor from London, at £5 5s. a-day, with an award in six

months or twelve months. In the meantime Paradise Row stands still, the brickmaker is disappointed of his money, the timber merchant's bills fall due, and the whole town is set by the ears, about a question which a practical man in the locality would have settled, if it had ever been raised, in half an hour.

The real meaning of the reference to the Central Board is to give an excuse for the cost of centralisation, to work out the theory that Messrs. Cowper, Taylor, Austen, and Simon understand materials, ventilation, and drainage better than the average of the architects, surveyors, and builders of England.

Legislators had better consider whether, desirable as light, air, and drainage are, this projected system of regulation and centralisation will not make the sanitary whistle rather too dear. If it is ever worked, our builders and architects might cease to think at all—all the thinking would be done for them by the Central Board. One system, perhaps one style, of architecture would be stereotyped all over England, and the character of our artists and tradesmen would be completely changed.

An architect or builder, for no fault of his own, would find himself without employment—a black sheep—an excommunicated wretch. People would say, “Jenkins is a very decent, honest man, and a very clever builder, but the fact is, the Board of Health (Local or Central) don't like him, and he can never get his plans passed.” That was the way in which Mr. Chadwick treated every engineer who refused to

be the slave of his Lambeth Pipe theory. The Board of Health have inherited Chadwickian tradition.

The whole theory of central supervision of sanitary works is based on the fallacy that in this free discussing country the same crutches and leading-strings are required to enforce reform as in those continental bureaucratic countries where abstract essays and romances form the staple of the little sheets they call newspapers.

All that the people of England now require for carrying on sanitary reform, beyond proper powers of local self-government, is information. A temporary dictatorship of wisdom might have been useful in time past; but this Bill is an attempt to clothe mediocrity with powers which the wisest could not usefully exercise.

Clauses LII. to LV., like clauses already noted, manufacture work for the General Central Board in the way of inquiries and appeals, which are quite unnecessary. If the Central Board is so constituted as to inspire confidence (which it is not), there can be no need for an application to Parliament; if there is to be an application to Parliament, the inquiry of the Board of Health Inspector is a piece of useless expense. Any inquiry can be much better conducted by some local independent authority—a County Court Judge, a Commissioner of Bankruptcy. We have the reports of some score of Board of Health Inspectors before us, and they are wonderful specimens of dishonest ignorance. *See Southampton*, pp. 153–158.

In the ensuing chapters of this volume we have traced the course of the first Board of Health, and shown how completely the new theories and systems of drainage, &c., introduced with great pomp and official authority, have failed in every town in which they have been fully tried. Among these theories the greatest favourite with the author of the Board of Health, and most complete failure, has been that of easing a large rent by selling sewage water to farmers. (See chapter on Value of Sewage Manure.)

As farmers buy guano and superphosphate in preference to liquid muck, Clauses XXII. and XXIII. enable Local Boards to dabble in farming, and to buy lease land for the purpose of trying the liquid-manure system of farming. It has hitherto been considered contrary to sound policy that municipal bodies should become traders, farmers, or manufacturers. These obscure clauses open the door to an unlimited expenditure in a very wild speculation.

If the public health works of England really require a central controlling supervision; if anything more is required than a medical man of special qualifications as an adviser to the Home Minister, and an annual reporter after the fashion of the Registrar-General, then the Commissioners and officers of such a Board ought to be men whose practical and scientific reputation would inspire respect in the professions which they are intended to control. They ought to be engineers and architects of the first class. But first-rate architects and engineers will not stoop to become the tools of an empirical system—they

are better employed in giving examples of real work to other countries where private enterprise has been smothered under boards, schools, museums, and professors, and admirable reports, and they would never lend the influence of their authority to carrying out the system of Prussian despotism, which the Board of Health is anxious to establish.

The Board of Health, as at present constituted, is perfectly useless, but harmless; it is on the point of dying out for want of employment. Nothing is really needed except a medical referee and a small statistical department. The present Bill is an attempt to take advantage of a wearied Parliament to perpetuate a despotism, which, if wise, would be mischievous, but which, so far from being wise, is at once empirical and ignorant.

In the following chapters we have endeavoured to give an historical view of the theories, the works, and the impostors who have been engaged during the last eighteen years in trying to supersede Municipal Institutions, and to extinguish private enterprise under the pretence of carrying out Sanitary Reform. This work was intended as a second edition of Sanitary Reform and Sanitary Reformers, but it has been almost re-written, with considerable additions.

ENGINEERS AND OFFICIALS;
OR,
THE PROGRESS OF PUBLIC WORKS
BETWEEN 1838 AND 1856.

CHAPTER I.

THE IMPORTANCE OF THE HEALTH QUESTION.

HEALTH is the capital stock on which the great majority of our population have to depend for the means of earning an honest living. Fever, ague, cholera, and a variety of diseases—the result of foul air and foul water—which attack and prostrate whole districts at the same time, are as much a tax on national wealth, as much a loss to national power, as shipwrecks, earthquakes, wars, fire, or any other calamities that consume property and destroy life. A pestilence—whether, like the cholera, it assumes the awful shape of a general visitation, or like the low fevers which never entirely leave certain unhealthy districts, it is merely partial and local—arrests the useful, profitable labour of those whom it attacks, renders them involuntarily idle and dependent, instead of earners of wages and performers of work, and not unfrequently cuts down the strong hands, and leaves the feeble infants, or helpless widows, to

the support of parish or charitable funds. The ravages of death are not the most lamentable results of the onslaughts of disease—what may be called the wounded, who escape, to creep through life crippled, weakened for their remaining days, are still more to be pitied. They become the parents of children, who inherit and propagate their shattered constitutions.

There are whole districts in crowded cities, in which the population is always more or less diseased ; feeble, rickety, stunted, ill-favoured ; from the cradle to the grave it never knows the full blessings of active, vigorous, cheerful health. Such districts produce a certain annual crop of paupers, and worse.

It is only within the last twenty years, that health, or, as it is fashionably called, sanitary questions, have become the subject of public opinion. Learned physicians have written on the subject—onslaughts of wide-spreading disease have frightened the people or the Government of the day into temporary measures for compelling public cleanliness ; but it is only within a very few years that the “Public” have begun to see the necessity, in fact the economy, of sinking capital in what may be called the fortifications of health—in drains, sewers, and water supplies ; in paying the annual cost of inspection which is necessary to ensure ventilation and cleanliness, and guard against overcrowding in the lowest class of city dwellings.

Pure air and pure water, if we may judge from the rude health which sailors, shepherds, fishermen, gipsies, and savage tribes enjoy, will make amends for coarse uncertain supplies of food, scanty clothing,

insufficient shelter, and many hardships. The followers of such hardy out-of-door occupations are fresh, clear-complexioned, strong-lunged, and able to defy hunger and cold; if they are not, they soon die. But in an atmosphere of foul air, such as is breathed in the crowded back slums of our populous cities, a pallid, feebly unwholesome appearance, a stunted growth, a shambling gait, all the signs of permanent debility, characterise the inhabitants.

It is impossible by any legislative contrivance to provide food, clothing, and house-room for the great bulk of the population. To attempt the task, would be to pauperise them in a mass, to render them perfectly helpless, hopeless, and dependent as young children.

In England, the limits of useful legislative assistance have been reached by the Poor Laws, which are intended to provide a bare subsistence for the able-bodied, unable to obtain work, and kindly care for destitute young children, the aged, and the crippled.

But although the State would do harm by interfering wherever the work can only be best done by private charity and private enterprise, there are certain works which must be regulated, and certain precautions which must be taken, by law, and supervised by public officers, because they are of the class commonly called "*everybody's business and nobody's business*;" and it is only by the joint-stock powers of a Government, or of a municipality, or a Board representing Government, that the needful funds can be conveniently raised and properly expended.

It is thus that roads are made, and police and armies maintained. The public submit to certain taxation, and give up a certain degree of liberty, in order to enjoy better means of travelling, safety from criminals, and protection from foreign enemies. And it is on these principles that gas companies, water companies, and railroad companies have been trusted with special powers, in return for the public benefits they have undertaken to afford.

Within the last twenty years several causes have combined to direct public attention toward the public pecuniary advantage that would be derived from the systematic supply of pure water, and removal from our houses and streets, of superfluous water and everything likely to breed corruption and produce malaria (that is, the disease of bad air), and of so regulating the construction and occupation of the dwellings of the poorer classes that they shall cease to be hotbeds for the propagation of filth.

A village planted on a dry soil, on the side of a hill sufficiently supplied with water, may be kept clean, sweet, and healthy, with very little artificial assistance; and if, whenever a new town was founded, preparations were made from the beginning for making the ground dry—which is the first condition of health—for carrying away all soil and refuse, for providing an ample supply of pure water, and for the perfect ventilation of every cottage, court, and narrow street, the task of health legislators would be comparatively easy; they would have nothing to undo, nothing to clear away. The underground work,

which it now costs so much money to excavate, would be laid out before the houses were built, and no blind courts or narrow alleys would ever arise to be peopled by perpetual fever patients. For all the future streets of the metropolis, under the Acts of Parliament, to which in our text we shall refer, these necessary precautions will be taken. But it is not possible to call great towns into existence at the will of a landowner and an architect; towns grow and populations concentrate where money is to be made, and seldom attract attention until the evils of overcrowding appear.

It must never be forgotten that the health question is not a future but a present question; that it must always be considered, not as if we were dealing with some future city and population, but with houses already built, streets already paved, works of sewerage, drainage, and water supply, more or less perfect, already executed; and with a population whose habits are not to be altered in a day by an Act of Parliament, or a pamphlet of good advice.

Men are not machines, to be moved exactly as an engineer or a commissioner desires. The world we have to deal with is not a blank, flat sheet of paper, open to receive the geometrically divided, coloured plans of a fervid schemer. The health question is a practical question, and cannot be settled like a game at draughts or a sum in arithmetic, as enthusiastic amateurs, who see no difficulties where their pet theories are involved, would have us believe.

For instance, it is universally admitted that it is

8 PRACTICAL DIFFICULTIES OF THE HEALTH QUESTION.

essential to the health of towns that they should be provided with a set of sewers or drains capable of carrying away the contents of the water-closets, and all the offensive refuse of towns which comes under the general name of night-soil, as well as the surface water of rain, or the overflowings of water supply.

It was comparatively easy to plan such a system for the village of Salter's, near Bradford, because the streets were planned before the houses were built, the whole property belongs to one man, Mr. Titus Salt, and all the inhabitants are his tenants. It was almost as easy to provide for the wants of a village like Sandgate, of one street, and less than 3000 inhabitants; but when it becomes necessary to provide for a population like that of London or Manchester, then a thousand details, natural and artificial, have to be considered, which never occur to the amateur reformer who projects his schemes with a rule, a pen, and a bottle of red ink, looking over a flat plan, which to his unpractised and enthusiastic eye shows no difficulties.

In the one case the sewers may be counted in yards, in the other in miles; the inhabitants by hundreds, instead of hundreds of thousands; the sewage by quarts, instead of millions of gallons.

The modern drainage system, by which it is required that all sewage matter be conveyed out of town by subterranean sewers in a liquid, instead of being carted away in a semi-solid form from cesspools periodically emptied, is a luxury or necessity of scarcely older date than the invention of mackintoshes, and

requires for its proper execution no ordinary amount of expense and skill.

The solidity of pavement wherever constant traffic passes—the works of gas companies and water companies which must be disturbed by every fresh excavation—the depth and extent of the cellars of great cities—the soft alluvial nature of the soil so often met with when the excavations have to be carried through ancient and populous streets,—all these are engineering difficulties—serious causes of expense and delay—requiring great local knowledge as well as professional skill in order to reduce the cost and inconvenience to the lowest point possible; but they are treated very lightly by those who have no professional reputation to lose by engineering failure, and no share of the cost of failure to pay as shopkeepers and ratepayers.

It was no doubt a consideration of the many difficulties to be encountered in dealing with the great sanitary works required in great cities which caused Robert Stephenson (the most eminent engineer of the day, a man who combines in a very high degree scientific acquirements and practical experience with a judicial order of mind) to observe on an occasion when the empirical decrees of the Board of Health were under discussion, “that when he first joined the Commission of Sewers, he believed that he did understand the subject, and that he could have designed any work of the kind to the perfect satisfaction of the inhabitants, but he soon discovered that *his previous engineering experience, although*

it aided him, did not enable him to take into immediate consideration all the numerous bewildering local circumstances and domestic difficulties with which the subject was surrounded; and he must say, while he almost envied the self-confidence, that he was astonished at the daring of a Board of non-professional men who had not hesitated to lay down definite rules to meet all cases of this most indefinite branch of the profession."

But Mr. Stephenson forgot that in the confidence and daring of a well-paid non-professional Commissioner, there is nothing so very astonishing: confidence is the great stock in trade of an empiric, just as patriotism is the last refuge of a scoundrel. A St. John Long or a Professor Pullaway prescribes his acrid friction or purgative boluses, in all cases, to all ages, and both sexes, without a moment's hesitation.

CHAPTER II.

DRAINS AND SEWERS.

THE direct use of drains and street sewers ought to be to carry the filth of houses and streets away to some distant point, where it will cease to be a nuisance and an injury to health; and, where they are properly constructed, assist to dry or drain the soil in which they are laid—a very important object. The sewers of our great towns were originally constructed with the view of carrying away rain-floods only. The soil of houses was regularly led into cesspools, and thence carted away into the country. The extension of water supply first, and then the invention of water-closets, led people to make use of sewers to wash away night-soil. By degrees what was illegal became legal; but the result was, that many sewers constructed sometimes by architects, but oftener by bricklayers and builders, for carrying away rainfall were not suited for carrying away the miscellaneous contents of sewerage.

When, about fifteen years ago, an agitation on health questions commenced, the condition of the sewers of the metropolis was far from satisfactory.

They were managed by separate Commissions, with an imperfect system of communication and comparison between the different surveyors. Each adopted the size, shape, level, and direction of sewer that he thought best. Under such miscellaneous arrangements it was not difficult to find a list of instances of every kind of mismanagement, neglect, and misconstruction. But all that is past—the necessity of combination in sewerage arrangements is universally admitted among engineers, and now settled by Act of Parliament; but it is necessary to refer to past errors because an empirical official party who desire to regulate the laying of every brick in England, and to be paid for their superintendence, make an exploded system their stock in trade; although it has no more to do with the present practice of engineers than the old women's treatment of the small-pox, before vaccination became the law, has to do with the practice of modern surgeons. It, however, proved by papers laid before Parliament in 1853, that the worst works of the old Metropolitan Commissioners before 1842 were rivalled by the costly failures of Mr. Chadwick's amateur Commission of 1849 (Board of Health, from 1848 to 1854).

The most eminent civil engineers are agreed that the sewers (with certain exceptions which will be explained) should be of a capacity to carry off the daily sewage and provide for house drainage, subsoil drainage, and surface drainage. The quantity of house drainage and of subsoil drainage per day may be calculated with tolerable accuracy, but surface

drainage, which depends on rainfall, varies from year to year to the extent of several hundred per cent. A dry season of several months, like the spring and summer of 1855, is often followed by thunderstorms, which deliver at the rate of many inches in 24 hours, although the average of the year may not be more than $\frac{1}{4}$ inch per day. For instance, on the 4th of October, 1855 (afternoon), the rainfall was at the rate of 2 inches an hour for eight minutes. The rate at which rainfall will flow into the sewers will depend on the nature of the surface and the fall of the ground. A rainstorm will fill sewers much more rapidly from the pavement of Holborn Hill than from the grass of Hyde Park.

But a town can no more be drained by averages than a population can be fed by averages. A certain daily minimum of food is required to keep a population alive, and the want of it will not be compensated by a large supply making up a large annual average at some future time. For want of attending to this fact, people who quote statistics now and then make absurd blunders in their arguments.

In a small town, situated on a slope, a great storm of rain may not cause any serious inconvenience, especially if there are no cellars or underground constructions.

But in a city extending over acres, where the levels vary, foundations are deep, and property of immense value is deposited in vaults, it is essential that the effect of the greatest thunderstorms should be absorbed with the utmost rapidity. Board of Health

14 SEWERS OF GREAT CITIES SHOULD BE MONUMENTAL.

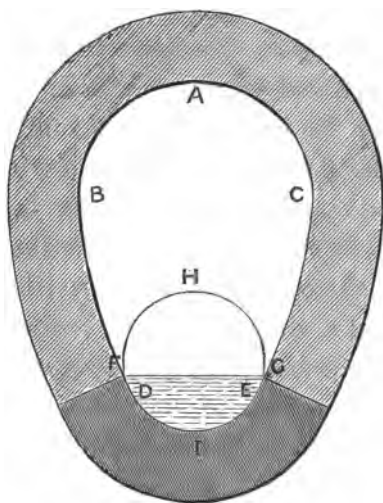
Reports sometimes refer to Lincolnshire Fens for an example of the facility with which floods may be pumped away by steam power; but they forget that, although a six-inch flood might do a field no harm for a week, it would be very inconvenient in a street.

It is of the utmost importance that the sewers of a great city, once constructed, should be of such a plan and execution that they can remain undisturbed externally, in spite of any of those obstructions that are certain to occur from time to time, as experience in small and great towns has proved, in sewers of every size, shape, material, and names, under the very best arrangement. To take up the pavement and divert the traffic of a quiet town like Sandgate or Rugby is a matter of trifling importance. It is only a few country carts and half a dozen gigs sent round in the course of the day; but to stop the Strand, or the Poultry, or any other London thoroughfare, is a serious responsibility for the engineer, and a serious tax on the shopkeepers. A stoppage in a leading street will cause the business of a retail shop to fall off below even its daily expenses; in a word, the danger, inconvenience, and expense of excavations in great cities are so incalculable that sewers ought never to be opened after they have been once completed—in a word, not makeshifts, but monumental.

For carrying away the sewage of London two kinds of conduit are used—brick sewers and glazed pipes.

“The London egg-shaped sewers are admirably

adapted to answer the triple purpose of draining the soil, carrying away the sewage and the rain; we select, for illustration, the ordinary size used—namely, a sewer of 9 inches brickwork, 3 feet 9 inches high, by 2 feet 6 inches wide internally.



“ Its crown, B A C, is a semicircle of 30 inches internal diameter. Its sides, B D and C E, are segments of circles, whose diameters slightly exceed 8 feet. Its invert, D I E, is a segment (about 116 degrees) of a circle of 18 inches diameter. The invert, and also a small portion of each side (D F and E G), extending somewhat above the ordinary height of the sewage flowing through the sewer, are composed of a hard impermeable brick, laid in cement.

“ With the ordinary flow, the sewage runs through an 18-inch channel, differing (so far as the part of the

sewer actually in use is concerned) in no respect from an 18-inch pipe sewer, except that it is made of hard brick instead of glazed stoneware.

“By here and there laying a few bricks dry (or some equivalent device) at or about the level (B C) of the springing of the crown, admission is given to the sub-soil drainage far above the level of the ordinary flow of sewage, without at the same time permitting the sewage to escape and saturate the soil.”

In this sewer the upper part is of sufficient capacity to carry off the floods of storm-water without danger of flooding surrounding cellaring, or bursting; and if by chance old hats, dead cats, scrubbing-brushes, or any of the thousand and one miscellaneous pieces of rubbish, find their way into the sewer (which have upset the whole economy of streets where pencil-case-like tubes have been laid, and which will continue most improperly to find their way there in spite of law, rules, good advice, and any amount of “education,” as long as there are cooks, butcher-boys, and scullions), then there is either room for the sewage to flow on and over the obstruction until it is removed by flushing, or by a flood of storm-water; or if it should resist flushing, then the size of the sewer enables a workman to enter and clear out the choked-up sewer, and at the same time repair it or any of the house-drains running into it, without the expense, delay, or public nuisance of breaking up the street.

During the last ten years earthenware pipes have been advantageously substituted as house-drains for the small brick sewers formerly used. And they

are also in certain cases found to be an efficient and economical substitute for brick street sewers.

Since 1844 these earthenware pipes have, under the double influence of demand and competition, been much improved in quality and reduced in price, and have become most useful instruments in carrying out sewerage works when suitably applied and carefully laid. They can be advantageously substituted for brick sewers in streets where the soil is sound and not retentive of water—where the length required is short, the traffic not great, the fall to the outlet very much down hill, the daily supply of water above average in quantity and force, and the facilities for the escape of the rain surface floods ample.

On the strength of this difference of price between brick sewers and pipes, on the assumption that glazed pipes (because glazed and of narrow dimensions) are *self-cleansing*, the Board of Health of 1854 asserted that what it calls the combined and back pipe drainage system can be executed at less than one-third the cost of the engineer's system. But experience has contradicted these assumptions and assertions. Pipe sewers, laid down on the model system, choke up like any other sewers, and more frequently, because they are small. The sewerage of towns drained on the official system has generally cost three times the estimate, besides being constantly out of order and in possession of the pipe layers.

Therefore an estimate for draining a town with earthenware pipes under the idea that the work once

done is done for ever, is certain to lead the town taxpayers into awful miscalculations, as has been already proved in London, Croydon, Dover, Sandgate, Folkestone, Southampton, and many other towns which will be mentioned more at length in another chapter.

Pipe drains are subject to three serious defects or accidents—imperfect joints, fracture, and obstruction. The ends may be imperfectly joined either from fracture, mis-shape of joints, or failure of the cement, and thus soak the sewage into the soil instead of conveying it away, as at Sandgate ; or the pipes may be crushed by the pressure of the soil, or broken by the sinking of the bottom level, as at Croydon ; or some foreign substance, road dirt, rags, oyster-shells, scrubbing-brush, a bullock's heart, or other of the thousand and one things thrown into closets and sewers, may choke it up, as in repeated instances in London and Croydon. In such a case, as soon as discovered, there is no remedy but to break up the ground again, and hunt for the exact place where the breakage or stoppage has taken place—no very easy job in a long line of streets, and only to be guessed by ascertaining where the house drains cease to run, or where the houses cease to be flooded. If you are lucky, and dig down within a rod or so, by raking and poking the drain may be cleared ; if you miss it, you must dig down again until you have found out your difficulty. When the obstruction has been cleared, the two ends of the pipe system have to be refitted, and this is an operation which, from the disturbance of the soil, it is difficult to make good ; where you come to a fall

of only an inch or half an inch in a hundred feet, it is extremely difficult to preserve the gradient—the very men walking over it will disturb it. But very often, if the soil is porous, a crushed pipe or open joint allows the sewage to escape and sink into the soil, forming a cesspool of the worst description, without the warning of any stoppage of the drains; and the first notice appears in the shape of foul smells, creating dangerous diseases, fever and cholera, as at Sandgate and at Croydon.

What may be called the Chadwickian system of town drainage, (for, with the exception of humble engineering echoes, no man of reputation and independence has supported it, and a long range of experience has shown its utter fallacy,) has been recommended to the public in many thousand blue books, distributed gratuitously at public expense between 1848 and 1854.

It consists in the exclusive employment of these earthenware pipes of extremely small dimensions, varying from 3 inches to 15 inches, but chiefly 4 inches and 6 inches for public, and 3 inches for private, sewage; in making a second set of drains running parallel to the backs of houses, combining houses in blocks, so that when one stops all stop; in providing a third class of drains for carrying off surface and storm water, where old brick sewers are not already provided and available for that purpose.

THE THAMES AND THE SEWERS OF LONDON.

The complete sewerage of the metropolis is one of the first questions which the Metropolitan Board of Works, the Vestries, and the District Boards will have to decide and execute. It is a great question, for the space, the population, and the traffic are all enormous. The population approaches 3,000,000, inhabiting 300,000 houses, distributed over an area of some 125 square miles, or nearly 80,000 acres, in numbers varying from 30,000 to 150,000 souls to the square mile.

The public and private sewers already constructed (on which, between 1848 and 1855, more than a million sterling has been expended) amount to at least 1000 miles, and these discharge daily from the north side of the Thames above 60,000,000 cubic feet, equal to more than 1,500,000 tons, or a pool of filth 5 feet deep, and as large as Hyde Park; and from the south or Surrey side, about a fourth of that quantity, equal to a pool as large as St. James's Park, and 7 feet deep.

The annual cost of flushing or washing out these sewers is little less than £25,000 a-year.

The street sewers urgently required amount to 400 miles, beside the cost of the new main intercepting channels required to free the Thames from the foul flood now daily poured into its waters.

The mere execution of London sewers is no easy undertaking. They are sunk from 14 to 65 feet in the ground. The work to be done is scattered over the

great thoroughfares, and passes below the foundations of houses, thus requiring most special precautions to avoid injuring adjoining property. Every yard of earth has to be removed by hand, and therefore, although the total quantities often equal a railway cutting or an embankment, it is never a straightforward work, in which trucks, tramways, and locomotives can assist hand labour.

The sewer work which urgently requires to be done is of a twofold character—ordinary street sewerage, amounting, as before observed, to upwards of 400 miles, and the construction of a system of main channels for diverting the whole sewage of both banks from the Thames.

But the magnitude of such a task does not in the slightest degree abate the ardour of the “enthusiastic amateur.” In every public assembly in which the subject is discussed there are to be found a score of sanguine individuals prepared to drain away or deodorise the whole sewage of London at the outlay of a few thousand pounds, on which they promise an enormous dividend, to be obtained from the sale of the solid or liquid refuse.

The deodorisers appear with a couple of phials and a wine-glass; one phial contains sewage, the other their patent deodoriser, and while the assembly gape round, the wine-glass is two-thirds filled with sewage, then a few drops of the magic liquor are poured in, and, hey, presto! the wine-glass becomes clear as crystal, except a small deposit at the bottom. And then the patentee, Mr. A., B., or C., states confidently

that he is prepared to clear the Thames without troubling the engineers; he only requires a dépôt at the mouth of each riverside sewer, and the daily million tons work shall be done as easily as the wine-glass experiment, with a great profit from the solid refuse. For the present, we will only observe that the profit remains to be proved. About the possibility of deodorising sewage there is no doubt, and that there are several ways of doing it. But it does not require any argument to prove, that if sewage manure manufactories are required, they cannot be too few or too far off.

Next to the deodorisers come the amateur engineers. The committee of an hospital never call upon their physicians to state the nature of their prescriptions, or undertake the management of a ward on experimental principles. A shareholder in a railroad company, who proposed to teach the engineer how a new line should be laid out, or how a locomotive should be built, would be instantly coughed down. But amateurs undertake to teach professional men how to arrange the sewerage of London with as much confidence and as little preparation as a school boy commencing to manufacture a kite.

DESCRIPTION OF LONDON DRAINAGE.

“The *arterial* (main) system of drainage now existing in London in the districts North of the Thames,” occupies the bottoms of the valleys running from north to south, and traversing the districts between the

high grounds of Hampstead and Highgate and the river Thames.

The 1st, the Ranelagh, drains a valley which commences at West End, Hampstead, passing through Bayswater, and terminating in the Thames near Chelsea Hospital.

The 2nd is the King's Scholars' Pond Sewer, which commences on the south of Hampstead, following generally the direction of Finchley Road, running through Regent's Park, down Baker Street, passing near to Buckingham Palace, and terminating in the Thames a little to the west of Vauxhall Bridge.

The 3rd, commonly called the Fleet, rises between Hampstead and Highgate, passes through Kentish Town, close to the Great Northern Railway Station, and by the Fleet Valley to the Thames, near Blackfriars Bridge.

The 4th is the Walbrook, which descends from the high ground in the neighbourhood of Islington, passing through Pitfield Street, close to the Mansion House, and thence by Walbrook to the Thames near London Bridge.

The 5th is the Hackney Brook, which rises near Highgate, passing through Holloway, Stoke Newington, and Hackney, and thence into the river Lea, near Old Ford.

The first four of these may be regarded as more strictly metropolitan, as they all pass through the densest portion of the population, and discharge into the Thames above London Bridge. The Hackney Brook traverses a suburban district; and its dis-

charge into the Lea, and thence into the Thames, is at a point considerably to the east of those portions of the river which have been so loudly complained of.

As to the south side of the Thames, "half the southern area extends along the bank of the river, and the surface of the ground is generally *below* high water, in some instances as much as six feet. This part is in fact a marsh which has been reclaimed from the river by embankments, and closely built over and inhabited. Many of the sewers beneath basements and cellars are so low that they can only discharge their contents into the river for about four hours each tide. Thus these sewers become reservoirs of stagnant sewage for sixteen hours every day, and unavoidably accumulate deposits.

"The remaining portion of the south Metropolitan area rises gradually from the level of the low district to an extreme elevation of about 350 feet; it is at present thinly covered with buildings, which are, however, rapidly increasing. The rain-waters of the high district descend rapidly into the sewers of the low district, which, being tide-locked, become overcharged when rain-storms and high tides occur at the same time, and flooding over, fill the cellars of Lambeth and Southwark, and with foetid sewage water destroy property to an incalculable amount.

"All the sewers on both sides of the Thames are becoming daily more charged with sewage, in consequence of the increase of building upon the areas which they drain; and their inadequacy to give vent to the flood-waters is still more apparent;

for, as the open lands and gardens are becoming occupied by dwellings, the area upon which flood-waters are retained and allowed to flow off gradually, is sensibly diminished. The natural consequence of this change of circumstances is, that the floods descend with increased rapidity, and gorge the main sewers in the lower districts towards the Thames, in some instances, far beyond their capacity of discharge.

“These alterations of circumstances, arising out of the extension of the area upon which buildings are daily growing up, cannot be looked upon as having reached their limit. We must assume, therefore, that large portions of the above districts will go on increasing in population, and that the discharge of flood-water will become more and more unmanageable; and that sewers in the lower levels, which originally were abundantly large, but which have now become in a great measure inadequate, must shortly become wholly insufficient.”*

Two objects, then, are required to be effected—the one to relieve the Thames from pollution, and the other to provide a discharge for the sewage and drainage constantly increasing with the increase of the population.

A considerable part of London, especially as already mentioned on the south of the Thames, lies either below the level of the Thames at high water, or too low to construct sewers with sufficient fall to keep a constant flow toward the distant points on the banks of the Thames, at which it is

* Stephenson and Cubitt's Report on Roe.

desirable they should discharge their contents. The only mode of conveying the sewerage from the low levels to points at which it can be discharged low down on the uninhabited banks of the Thames is by pumping with steam-engines. Pumping is a very expensive operation, and it is highly desirable to get rid of as much fluid as possible by its own gravitation (flow) by following, where possible, the slope of the land.

It must be remembered, that it is not only the rainfall, but the supply of water which each fresh inhabitant consumes, that has to be carried away by the sewers. The average rainfall is under a quarter of an inch in twenty-four hours, but a fall of half an inch in a few hours is not unusual; and an instance is recorded in which 4 inches fell at Birmingham in an hour. As sewers cannot carry off water by averages, engineers are agreed that provision must be made capable of carrying off a quarter of an inch of rainfall in twenty-four hours.

The consumption of water for the inhabitants of such a city as London, under the influence of soap-duty abolished, and baths popular, may fairly be taken at 30 gallons per head per day, which is less than half the consumption of New York, and about two-thirds the consumption of Boston, under the system of constant supply from the tap, instead of stored in reservoirs for two or three days' use as in London.*

As fields and gardens in the suburbs are covered with houses and paved streets, the rain which soaked into the earth and was evaporated, will flow rapidly

* New York 75 gallons, Boston 55 gallons, and Philadelphia 35 gallons per diem per head.

into the sewers, and the people who come to live in the houses built add to the flow by the water they lay on for water-closets, baths, and domestic purposes.

The result would be, that as population increased on the high level, the sewers lying lowest and nearest the Thames would annually receive a greater amount of liquid and solid sewage, and would require to be enlarged once, or oftener.

In 1854 a plan of sewerage was laid out by Messrs. Bazalgette and Haywood which divided the metropolis into separate and distinct zones, or breadths of streets, according to the natural fall of the land, and treated it as a collection of small separate towns, each with its own hills and valleys. Main sewers or tunnels running parallel with the Thames were designed for the purpose of intercepting the rain-fall and sewerage from the upper districts at a point where it could flow away by the force of its own gravity to the points selected on the banks of the Thames, viz. Barking Creek on the north side, and Plumstead Marshes on the south side. This plan at the same time protected the sewers of the lower districts from being gorged, and materially diminished the amount of sewerage to be pumped up from the level of the Thames to a point above high-water mark.

These *intercepting* or arterial drains were in fact artificial main rivers, rendered necessary by the greatness of the inhabited area, to receive and carry off the contents of common sewers.

The area below high-water mark on the south side

of the Thames it was proposed to maintain in unintermitting flow, and to drain dry the subsoil, now saturated by filtration, by steam pumping power, which, as Cubitt and Stephenson remarked, would have just the same effect as raising the whole district twenty feet.

Since the date of the Reports of Messrs. Bazalgette and Haywood, and of the consulting engineers of the Metropolitan Commission, Sir William Cubitt, and Mr. Robert Stephenson, M.P., the Metropolitan Management Act has transferred the direction of the main or intercepting channels for sewerage to the Central Metropolitan Board of Works, and divided the direction of the street sewerage among the boards of works of districts created by that Act.

Mr. Bazalgette, having been appointed the Engineer of the Metropolitan Board, has since prepared two reports on the two plans proposed by him for the interception of the sewerage and main drainage of the metropolis, with the same object as the previous plans, viz. of affording an outfall for every street sewer, and leading their contents far away from the inhabited banks of the Thames.

Into the details of the revised plans of the Metropolitan Board of Works it is not necessary here to enter. It is sufficient to observe that, according to the plan approved by the most eminent civil engineers, house or private drainage will generally be effected by a single row of tubular pipes, passing from the back to the front of each house in one operation, draining both the back premises

and the front area, which is all but universal in metropolitan houses. In certain special cases a combined system of draining houses in blocks may be adopted, but this expedient is not often advisable in consequence of the inconvenience and expense to which all the upper houses are exposed if the last be choked up. The house drainage will be carried as directly as possible into one of the network of street sewers with which every street is to be provided; and the contents of these sewers will be conveyed away by the large main intercepting tunnels, either by natural flow or by pumping to two points, Barking Creek on the north side of the Thames, and Plumstead Marshes on the south side, and there to be delivered at high water into the Thames, never to return again to the populated banks of the river.

COST OF THE THREE DIVISIONS OF DRAINAGE.

The expense of metropolitan drainage admits of very distinct divisions.

House Drainage, which is to be executed at the expense of the landlords on plans subject to the approval of the District Boards.

Street Drainage, which is to be executed by the District Boards, at the expense of each district, on plans subject to the approval of the Central Board.

Arterial Drainage, or main lines or subterranean canals, to protect the inhabited banks of the Thames from pollution by intercepting the general sewage, and the southern side of the Thames from

floods ; to be executed by the Central Board at the expense of the whole metropolis benefited.

Thus there must be—first, a standing rate imposed by the Central Board, to pay off the sum borrowed with interest to effect the arterial drainage, without which all other drainage will be insufficient ; secondly, a small annual rate to cover the cost of pumping ; and, thirdly, each district will have to impose local rates according to the requirements of its population for district sewerage.

The whole work may be compared to agricultural drainage, where each farm is drained by the owner into a brook under the care of the owners of the banks, and the brook into a river, which is public property.

We have not seen the estimates of the last scheme of interception, but the total cost of the north side and south side, according to Sir William Cubitt's revised estimate, 1854, intended to include "unforeseen items, inconceivable claims for damages, and compensation by public bodies and private individuals," was three millions sterling, which will probably be sufficient now, as there is no material difference in the plans, to complete the arterial and intercepting drainage of the entire districts north and south of the Thames.

ENGINEERING EVIDENCE.

Sir Charles Napier, the Earl of Dundonald, Sir Edmund Lyons, Captain Hall, and Captain William

Peel, have each their set of admirers, prepared to entrust them with the task of attacking Cronstadt, or any other difficult naval job; but there are not half a dozen people out of the walls of a lunatic asylum who would like to put the Baltic Fleet under the command of an amateur who had picked up his qualifications since the war began, by hard reading, and sailing model yachts on the Serpentine, with the assistance of a few boatswains, and perhaps a lieutenant shelved for stupidity, even though he rolled off the nautical phrases as glibly as glorious T. P. Cooke, in "Black-eyed Susan." Old women are tolerably successful in helping to bring the rising generation into the world; but in difficult cases, and where great interests are at stake, most people would, like the Emperor of the French, prefer the opinion of Dr. Locock. There are plenty of clever young men in the Temple and Chancery Lane, who have never held a brief or earned a guinea in their lives, but who are prepared on the shortest notice to give advice on the most intricate law cases; but ordinary people, when their fortunes are at stake, incline to act on the opinion of Sir Fitzroy Kelly or Sir Richard Bethell.

In fact, on all abstruse technical subjects, men of business give their confidence to men who have made a particular science or profession their study, and who by a long series of public evidences of their ability have justly gained the confidence of the public.

Ingenious students have not unfrequently suggested excellent ideas for use in practical work. Men of science, in the infancy of various arts, have made

improvements in such pursuits as cotton spinning, mining, and ship-building; but this always has been when the practical men were not men of science. But this kind of assistance cannot be rendered to modern engineers, because, in the first place, they are both men of science and men of practice; and next, their critics, Messrs. Chadwick, Ward, and Co., are men of neither science, nor practice, nor experience.

It is not to be expected that the electors and members of the new Boards of Works, as a body, have any precise knowledge of engineering, least of all, of that most abstruse branch, hydraulic engineering, in which water has to be dealt with as well as land. Having a great work, like that just described, to do, they must be guided by the opinions of professional men, who have acquired public confidence. In the case of the drainage of London, it so happens that Sir William Cubitt and Mr. Robert Stephenson, two engineers who have earned their eminent positions by actual work, have examined and reported on the plans in most elaborate detail—plans which have been prepared by two engineers, Messrs. Bazalgette and Haywood, who have had more experience—real experience—than any men in Europe. Before relating the objections raised by the enthusiastic amateur engineers of the Chadwickian School, we will state shortly, avoiding technicalities as much as possible, what Stephenson and Cubitt have to say to the London drainage plan of 1854, which, in all its main principles, is the same as that now under the consideration of the Metropolitan Board of Works.

On the 30th of October, 1854, they came to the following conclusions :—

1. That the design of interception proposed by your engineers, Mr. Bazalgette and Mr. Haywood, the engineer of the City Commission of Sewers, is better calculated than any other to effect the object.
2. *That the dimensions they have fixed upon for their sewers are not larger than are absolutely required to clear the Thames generally throughout the year from pollution.*
3. That even with these dimensions, the Thames will occasionally, during very heavy storms, still be liable to have discharged into it, for a short period, some portion of sewage, sent in a highly diluted state.
4. That in the distribution of the areas of interception, your engineers have succeeded in equalising the duties to be performed by each line of interception, as far as practicable: and thereby in reducing the quantity of sewage that may, under extraordinary circumstances, be discharged into the river Thames.
5. That, with this view, they have judiciously extended the local district sewer called the Hackney Brook, through Kentish Town and Camden Town, to Kilburn, by which the flood-water, from an area of seven square miles, is entirely separated and carried away to a point where it cannot, in the remotest degree, interfere with the lower districts of the metropolis.

“ The most important and essential parts are in the following order in which they should be executed. First, the high level catch-water intercepting drain on the south of the Thames, which will deliver, at all times, the small quantity of sewage and the large and uncertain quantity of storm-water which is produced on an area of 12 square miles, or 7680 acres, between the rivers Wandle and Ravensbourne and the watershed line south, the whole of which would pass into the Thames at all times, at or below high-water level, thus relieving from sud-

den floods of storm-water the whole of Southwark, the water-side premises from Vauxhall Bridge to Deptford, and various portions of Lambeth, Battersea, &c., at the same time rendering it quite possible to drain, by artificial means, the whole of the above-named districts between the high level intercepting drain and the Thames, containing other 12 square miles, which at present cannot be efficiently drained, as almost the entire district lies below the equinoctial tide level, and a great portion of it, the basements of the houses in particular, below even low-water level. Second, the low level drain or sewer extending from Battersea Fields to the Ravensbourne, under which it would pass into a pumping station. This, with its branch, would intersect and communicate with all the existing sewers, the present mouths of which in very heavy rains would serve as safety-valves to discharge the storm-waters before they could accumulate and flood the houses of the inhabitants, and engender disease as at present. But to effect all this, the present outfalls of the sewers would have to be improved, and turned into escape valves, shutting out the tides, and the high tides dammed out by raising the quays.

“The works might be completed in two or three years, if set about in earnest, and *the quicker they could be carried out the less they would cost.*

“The work of next greatest importance, and one which is within itself, and unconnected with others, is the North (of the Thames) High Level Drainage, or Hackney Brook; all the other works on the north of the Thames might then follow in the order stated in the report of Messrs. Bazalgette and Haywood.”

CHAPTER III.

SANITARY REFORM AND SANITARY REFORMERS FROM
1842 TO 1849.

AN ILLUSTRATION OF "THE REVERSE OF WRONG FALLACY."

HAVING in the preceding Chapter briefly sketched the present wants of the metropolis, in respect to drainage and sewerage, and given an outline of the principles on which educated engineers propose to execute the works required for protecting the Thames from pollution, and our streets and houses from the damp and foetid exhalations of stagnant sewerage, it may be useful to pursue the Health question a step further, and give some account of the measures which have been from time to time, with very unequal success, adopted for improving the health of our towns; and of the officials, who, with great industry and more zeal than knowledge, have made it their business to agitate for what is called Sanitary Reform—a reform, or rather a phrase, which, by their exaggerated promises, their practical failures and impracticable tyranny, they have succeeded in making most distasteful to the tax-paying public.

Before the days of the Reform Bill, the way to place, power, patronage, and perhaps a pension, for an able,

energetic, political, lawyer style of man, lay through a rotten borough. Once securely seated in Parliament, he made himself so useful or so annoying to the ruling powers that he got his price, whether it was money or honours, or both. Times are changed, and now the readiest road to official fortune is through a good public grievance, and a commission of inquiry. If our able man can once find an opportunity of stating his "*case*" on behalf of the injured community, his fortune is made. He proves the urgent need for further inquiry; and that he, as commissioner or secretary, is the indispensable inquirer. A report follows, piling, mountains high, the distresses to be relieved, and the remedies—of which one is the creation of a new office, moulded to the exact dimensions of our philanthropic advocate; the office is, perhaps, temporary, but an ingenious mind, with the help of annual reports, soon contrives to make it permanent. In these reports the ignorance of every one—except the philanthropist commissioner—is set forth at great length with many piquant anecdote illustrations. Wherever the commission or board had full powers, there the ameliorations have been striking, but the public are obstinate, the professions or trades opposing corrupt; * pure virtue, absolute wisdom, and model reforms are only to be secured by increasing the powers of our official philanthropist;

* "The active hostility of professional engineers unaccustomed to such checks" (that means, having their plans pirated and used), "called upon to change their principles and practice of construction, and to reduce their emoluments."—*Report of the Board of Health*, 1854.

and so, from year to year, the profitable game of commissionership goes on until, perhaps, intoxicated with success, the inventor of the paid authority turns the official vice rather too hard, and gets kicked out or up stairs into a pension and Companionship of the Bath.

But for this sort of success, even with the cleverest man, there must be a real foundation — an unmistakeable grievance. The more real the grievance, the more brilliant the prospects of the adventurer ; just as in time of pestilence and famine quacks flourish, and false prophets and mob orators find willing dupes.

In 1838, the sanitary condition of many towns in this country was frightful. Death ravaged, and disease perpetually prevailed among crowded populations, which in the course of centuries had been gathered together by the demands of commerce and manufactures, without adequate precautions for securing fresh air, pure water, and the removal of sewerage.

The attention of the Poor Law Commissioners was directed to the subject, and after having collected a mass of information, they placed it in the hands of their secretary, Mr. Edwin Chadwick, for digestion. The result was the report on the Health of Towns of 1842.

Mr. Chadwick is unquestionably entitled to the credit of having created a public opinion in favour of sanitary reform ; of having pursued the subject of sewerage, drainage, and water supply through a long

series of years, with a fixedness of purpose really admirable; and if he had been content with his special vocation as an advocate and agitator, a searcher-out, reporter, and exposé of abuses, he would have rendered essential and unquestionable services to his generation. As a detective officer, as a grand inspector of nuisances, as the draughtsman of a report with very clear conclusions, he has no equal,—his services were cheap at £1000 a-year* (although he stands alone in having earned so large a pension for work created on his suggestion, and executed in a very few years). But nothing less than absolute unquestioned power will satisfy Mr. Chadwick. We do not take him to be a corrupt man. He has been well paid and handsomely pensioned, but not better than, with his industry, he would have been in many other pursuits. It is a mistake to imagine that mere money profits are the leading objects of active ambitious minds: power, patronage, and popularity—these are sweet prizes, appreciated by men to whom outward show and personal luxury are matters of indifference. The late Sir Frankland Lewis, in the evidence before the committee on the grand row which broke up the first Poor Law Board, and transferred Mr. Chadwick to a sphere where he could reign without rivals, called him “a clever man, but perfectly unscrupulous.” Sir Frankland did not do

* It is curious that Mr. Chadwick, who is the author of the Poor Law Report arguments against pensions and provisions for the worn out, should have accepted a pension, in the prime of life, instead of relying on his own savings. Miss Martineau, on principle, refused a pension.

him justice—he is unscrupulous, but more than clever; Sydney Smith's sketch of a certain zealous grasping prelate fits him admirably: "*passionately fond of labour, no aversion to power, great ability, thoroughly versed (in selecting evidence), and always in London.*" And we may say of his works, as of the bishop's, that "they display great arbitrariness of proceeding, and much boldness of innovation, guided by no sure principle."

Mr. Chadwick's credulity is almost infantine when engaged in collecting evidence to support his already-settled opinions, but his scepticism is invincible, when facts, science, and experience combine to upset his favourite plans. He exhibits a curious example of the strictly legal as opposed to the scientific and practical order of mind. The scientific mind seeks to arrive at truth, the legal mind seeks to obtain a verdict. The legal mind, like Mr. Chadwick's, first jumps to a conclusion or theory, in fact makes a case, and then devotes all its powers to support that case, rejects—obstinately turns from—every circumstance, from every practical or scientific fact, that contradicts its settled theory, just as the passionate defender of a murderer will not see his client's guilt even after *confession*! Such minds, when endowed with the vigour, the persistence, the tenacity of Mr. Chadwick, are as absolute as popes. They surround themselves with living machines, who register their fiats; no servant, officer, or acolyte dares to hint a doubt of the success of any decree. Hence it is, that reports drawn up by Mr. Chadwick's Board of Health ignore the daily

instance of the choking-up of the pipe sewers, which he decided to be "self-cleansing," and of the regular working of the brick sewers, which he decided to be "sewers of deposit." Hence, tables of the cost of sewerage works in various towns are published in the 1854 report, with one-half of the cost omitted, and instances of total failure are cited as triumphant successes. Mr. Chadwick settled his system in 1848, and he would rather believe all the world wrong, rather see London made impassable, than permit himself to doubt that his theories, his dry water-works, and choked-up pipes are not perfection. He is like the French king, who never found any one always in the right except himself. To oppose him is to be guilty of high treason, to be excommunicated, to be attacked as a man actuated by the most corrupt motives, "incompetent, untrustworthy."

Mr. Chadwick's work of 1842, a "Report from the Poor Law Commissioners, on an Inquiry into the Sanitary Condition of the Labouring Population of Great Britain," was followed, in 1845, by the "Report of the Commissioners for inquiring into the State of large Towns and Populous Districts;" and in 1847, by the "Report of the Commissioners appointed to inquire into what special Means may be requisite for the Improvement of the Metropolis."

And these reports, carefully prepared for the purpose, led to the Board of Health in 1848, where Mr. Chadwick was the Board—as well as to the united Metropolitan Commission of Sewers of 1847, which superseded five separate Commissions for five dis-

tricts of the metropolis, where, until overthrown by their failures, Mr. Chadwick's followers were all-powerful.

No sooner were the first centralised Metropolitan Commission and the new Board of Health established, than the services of the printers were called into active use, and volume on volume of reports, with selections from evidence, all of one cast, profusely illustrated with pictures, plans, and diagrams, and tons of pamphlets on every point of the sanitary question, were written, printed, and circulated with a profusion only practicable where a public purse pays the cost, and an official, intent on unscrupulously securing permanent employment and unrestricted power, directs the operation of broadcasting.

We cannot pretend to enumerate the publications issued by the Board of Health; their titles alone would fill pages; but among the most bulky was a volume of 300 pages, in 1850, professedly a report on the water supply of London, which included the views of the Board on sewerage and engineering questions, and reproduced as facts certain absurd experiments of the Metropolitan Commission's Trial Works Committee; and in 1854, when the Act creating the Board of Health being about to expire, a report on their administration between 1848 and 1854, full of the most daring misrepresentations and exaggerations, was issued and circulated at the public expense—two publications to which we shall devote two chapters.

After travelling through this voluminous collection of documents, it is impossible not to come to the con-

clusion that they were all written by the same hand, or, at any rate, dictated by the same unflinching, determined, unscrupulous head. In a word, Mr. Edwin Chadwick suggested the original inquiries; settled the plan of operations; marshalled, selected, and digested evidence; grew from secretary into a commissioner; issued rules, regulations, and maxims; chose his colleagues, his servants, and his witnesses, and in his official capacity, under the mantle of the Board, tried, condemned, and sentenced his opponents; and recommended the Board, that is to say, himself, for further powers, privileges, and honours. Never has the expedient of reiteration been so vigorously and unscrupulously used, page after page, volume after volume, pamphlet after pamphlet, speech after speech; the same reckless assertions are supported by the same fallacious evidence, selected and cooked for the occasion, and the same certain conclusions are arrived at, that is to say, that every city, town, and village may obtain universal health and a large income from the sale of sewerage on one sole condition—unquestioning, blind, passive obedience to the ukase, decree, bull, or proclamation of the autocrat, pope, grand lama of sanitary reform, Edwin Chadwick, lawyer and commissioner.

It is impossible not to admire (without envying) the obstinate, persevering audacity of his career. He was determined that the British world should be clean, and live a century, but on one condition only—that they consented to purchase the real patent Chadwickian soap, the Chadwickian officially-gathered soft water, and the true impermeable telescopic earthen-

ware pipe, and when they did die, were interred by his official undertakers in the Chadwickian necropolis. The public admitted the disease, but they objected to the patent pill, draught, and undertaker.

The report of 1842 was a useful volume, in spite of mistakes and exaggerations. It drew attention to the importance of complete sewerage, drainage, water supply, ventilation, and special precautions in the construction of dwellings for securing health and extinguishing the sources of disease. It proved, in a manner that could not be denied, the neglected condition of a large percentage of our labouring classes, and showed the economy of taxing property to defray the expenses of compelling certain classes and certain districts to be clean, which could not be cleansed without compulsion. The importance and economy of water supply to every house, however poor—the sanitary effect of drying retentive soil by draining it—the evil effects of overcrowding lodging-houses and private dwellings—the beneficial effects of public walks and gardens,—all these points were admirably explained and enforced.

If, after 1842, Mr. Chadwick and his pupils had bent themselves as zealously to cure the evils they had made plain, as they did to secure for themselves despotic powers, absolute patronage, and the absorption of private enterprise and local government, in one unwieldy empirical government board, they might have earned the character of patriots and philanthropists instead of place-hunters and pensioners.

The second report of 1844-5 was signed by great

names, but it is evidently the work of Mr. Chadwick, and is an admirable specimen, in a literary point of view, of what a report intended to carry a given object ought to be—clear, definite, decided. The legislative penalties and provisions required for amending the sanitary condition of the poor are laid down with great force. The majority of these suggestions are excellent, and are now embodied in the Metropolitan Improvement Act, but throughout the paper there ran a series of “hints,” which passed unnoticed by the signers of the report, pointing to the establishment of a central despotic sanitary authority, to act in the name of the Crown.

Several of the Commissioners objected to certain paragraphs, but, agreeing in the main recommendations, signed, rather than make a sensation with a protest—the fact being, that the Commissioners had no idea of the ulterior views of their unseen reporter.

In the next volume—the first report of the *Metropolitan* Sanitary Commissioners—the plot thickened. The Commissioners were Lord Robert Grosvenor, Mr. Edwin Chadwick, Dr. Southwood Smith, Professor Owen, and Mr. Richard Lambert Jones; very good names all, but not precisely the authorities to condemn and set up principles of civil engineering as they did.

The apprehended visitation of the cholera was the foundation of this Commission of Inquiry. A mass of argument was brought together to prove that a considerable amount of disease was preventible by

proper sanitary precautions; an exaggerated picture was drawn of the mismanagement of the irresponsible Courts of Sewers, and of the defects in sewerage arrangements carried out by surveyors who had not graduated under Chadwick. The report concluded by recommending that "the several Commissions in the metropolis should be recalled, and the law of sewers committed (to insure dispatch and obviate the want of responsibility, which arises from its present division amongst large bodies) to a limited number of Commissioners, competent, through their known attention to sanitary improvements, to select and sustain the labours of paid officers in the attainment of works of this their proper object." The theory of this recommendation was not unreasonable; but the Commissioners went further, and on the text of the absurdities and neglect in construction and management of sewers shown in certain selected cases, they propounded the outlines of a small-pipe drainage system on the evidence of certain obscure and docile witnesses, who, curiously enough, all obtained appointments under the reformed Commission of Sewers.

The concluding paragraphs of this famous report contained the following sentences, scarcely noticed at the time, but which were, in fact, the commencement of a system of self-praise, and condemnation of the un-orthodox, in a Chadwickian sense:—

"The more the investigation advances, the more apparent it is that the progressive improvement and proper execution of the class of public works, toge-

ther with the appliances of hydraulic engineering, require a degree of special study, which not only places them beyond the discussion of popular administrative bodies, but beyond that of ordinary professional engineering and architectural practice. In justification of this conclusion we might adduce examples of most defective works which have received the sanction of names of general professional authority" (meaning Mr. James Walker, C.E.).

Subsequent events translated these mysterious words, which in 1850 were incorporated in the circulars of the Board of Health, and in the General Report of 1854, into this maxim: "No one is able to plan sewers or hydraulic works who does not accept Mr. Edwin Chadwick's engineering theories."

If, then, we pause and look back on the progress which had been made in sanitary reform between 1839, when the Poor-Law Commissioners commenced their inquiries, and November, 1847, when the Metropolitan Sanitary Commission made their report, we find the deficiencies and mistakes of existing health legislation very sufficiently proved. No candid mind could hesitate to admit that reform and active legislation were urgently required. And if, at this stage of the proceedings, Mr. Edwin Chadwick, who was undoubtedly the life and soul of the movement, had been really anxious to co-operate with the best and fittest men to do the work in hand in the best manner, he would have escaped, to use his own terms, as applied to the civil engineers who do not bow down to him, the "ludicrous, costly, and noxious

failures in practical matters" which have damaged his reputation, and seriously retarded the progress of health-promoting works.

The Report of the Metropolitan Sanitary Commissioners (who were the legitimate official offspring of a private Metropolitan Sanitary Association) led to the centralisation of the various Commissions of Sewers in one Metropolitan Commission in 1847, and to the establishment of the Board of Health in 1848.

Between 1847 and 1854 not less than six Metropolitan Commissions of Sewers were issued. The first, dated 30th November, 1847, included, in 22 names of lawyers, physicians, members of Parliament, and men of science, the following gentlemen who formed the Board of Health in 1848, and, with the exception of Mr. Bullar, continued in power as "Official Sanitary Reformers" up to 1854, viz. Lord Ashley, now Earl of Shaftesbury, Edwin Chadwick, Barrister, John Bullar, Barrister, and Southwood Smith, M.D.

The Commission issued January, 1849, included the same names as that of 1847 with addition of 18 names of Royal Engineers, the Astronomer Royal, two reverend mathematicians and others, but not one civil engineer or architect.

In these two Commissions Mr. Edwin Chadwick, who had called them now into existence, was all-powerful.

The Commission of 1847 began by dividing itself into committees of inquiry, as, for instance, into the construction of sewers, the value of sewage water, the

strength of pipes, &c.; and Mr. Edwin Chadwick, being also a member of the Board of Health, by degrees became a member of every important committee; "fond of labour, and always in London," he found in the Metropolitan Commission supporters, pupils, servants, and funds for carrying out his Board of Health plans of conquest.

Among these committees, first in importance was the "Trial Works Committee," by which evidence to be used in after-years was manufactured, and all faithful and convenient witnesses were rewarded, named, and costumed for future appearances in more important characters.

It was one of Mr. Edwin Chadwick's assumptions, that civil engineers knew nothing about hydraulics, or the laws that govern fluids; that being precisely one of the branches of practical science to which mathematicians and engineers had been obliged to pay special attention in the calculations required for constructing canals and docks in Holland, France, Germany, and England, and in Italy, for estimating the rent of the water supplied to irrigate land, water forming a considerable item of state and private income in Lombardy, Piedmont, and Tuscany. Du Buat, in 1785, recorded experiments which have been confirmed by the scientific and practical experience of the last seventy years, by the researches of Eytelwein, Prony, Torricelli, Smeaton, Rennie the elder, and Hawkesley, in our own time.

But the result of the experience of eminent engineers and mathematicians was unsatisfactory to Mr.

Chadwick. The prescribed dimensions of the pipes and sewers for the reception of sewage and rainfall were found inconveniently large by Mr. Chadwick and his friends ; they were, in fact, dimensions which did not admit of a balance-sheet so favourable as was required to prove the "extravagance" of civil engineers. Accordingly, the Trial Works Committee gave orders for a set of experiments. To perform these experiments were selected, not men of science or experience, but

J. Medworth, clerk of the works, or bricklayer's foreman, who afterwards retired to keep a public-house in Oxford Street ;

James L. Hale, another clerk of the works ;

J. Lovick, at that period of the same class ; but since by his talents very properly promoted to be an assistant engineer. As Mr. Lovick had his way to make in the world, he would have been more than human had he not been involuntarily influenced by the wishes of the "Great God of the Sanitary Ephesians."

No doubt all three were honest, respectable, well-meaning men in their way, but about as competent to make and record hydraulic experiments as the head mathematical boy at Christ's Hospital would be to check the astronomical calculations of Sir John Herschel.

The result of these experiments, which will be found quoted and re-quoted in thousands of publications issued by Mr. Chadwick's Board of Health, was in the highest degree satisfactory. The Clerks of the Works beat the philosophers by a long chalk :

3 gallons, 30 gallons, and 300 gallons were made to run per minute out of pipes of dimensions which, according to the scientific engineers of past and present time, would only permit a flow at the rate of 2 gallons, 20 gallons, and 200 gallons per minute. On this absurd evidence the Board of Health propounded their Quart-into-Pint theory, proceeded to reduce the dimensions of all the drain-pipes under their control one-third, and to denounce the systems of hydraulic engineers as "baneful, costly, noxious errors."

The Trial Works Committee expended £7180, of which upwards of £5000 were spent on hydraulic experiments—a cost singularly in contrast with the expenses of the Committees of the British Association for the Advancement of Science, by whom, for very important experiments, sums of from £10 upwards, rarely exceeding £100, are annually voted.

Five thousand pounds expended under the eyes of Mr. Edwin Chadwick, the zealous denouncer of the corrupt practices of Westminster Commissions and Parochial Local Governments, ought to have produced something, if not really useful, at any rate tangible and visible, in the shape of a Report and a Balance Sheet; but it is not so. Perhaps great minds, like Mr. Chadwick's, are not subject to the ordinary rules which he applied to the unpaid Commissioners, who spent no money on printing, but had the villany to dine together once a-year.

The examination by a Ratepayer of the books of the Commission, showed that under the Trial Works Committee "experiments had been made to the

number of thousands; some in the Fleet Sewers, some in Earl Street, some in the back yard of the office in Greek Street; some with large glass tubes, others with earthenware, others with iron and brick. The expenses had amounted to £700, £800, and £400 in a month. For such an expense a collection of the finest experiments ought to have been in the possession of the Commission. But there is nothing of the kind; the experiments are recorded in the most confused manner; they are contradictory; they are unintelligible for any practical purpose. There is nothing in this vast mass of experiments from which a single safe conclusion can be drawn.”*

These experiments were ordered to be reduced to a tabular form, so as to afford useful information as to what quantities of water would flow through pipes of particular sizes with such and such falls, &c. On the application of the Commission, Professor Airey recommended Mr. Stoneham (a gentleman from the Royal Observatory) to put the Trial Works experiments into the shape in which the experiments of Du Buat and other eminent hydraulic authorities are to be found. Mr. Stoneham made a report. But although the forms of arrangements and administration are admirably preserved in their every department arranged by Mr. Chadwick, the report was

* The experimenters (Clerks of the Works) came to the conclusion “that a 6-inch pipe laid perfectly straight would discharge 46 cubic feet, laid level—*there was an inclination of nothing and a head of nothing.* With a fall of 1 in 800, the delivery was increased to 46 $\frac{7}{10}$ cubic feet; and the delivery rose to 50 cubic feet with a fall of 1 in 240; they also obtained a discharge of 59 cubic feet with a fall of 1 in 120 |”

not to be found ; there were diagrams, too, but the diagrams are not to be found ; whether there were deductions or not we cannot say, but none are to be found.

It seems from the minutes of the Board, that the reports of the first set of experiments presented such a mass of contradictory figures, statements, and results, that a second set of experiments were ordered to be tried. The diagrams of the second set of experiments are in existence, and open to the inspection of any ratepayer. On the margins of some of them are to be found such notes as the following, signed by a reverend mathematician and then Commissioner, "Not credible.—Morgan Cowie." "Some mistake here." "Impossible.—M. C."

The mathematicians of the second Commission, concluding that which had cost so much money must be of value, ordered the papers recording the experiments to be collected, arranged, and printed ; but the results when in print verified the notes of the reverend mathematician, and were so confused, contradictory, and absurd, that they ordered the book to be suppressed. A copy, however, saved from the fire, was produced at an hydraulic discussion of the Institute of Civil Engineers, 20th of February, 1855, at which we happened to be present.

It would be natural to conclude that Mr. Chadwick would have been satisfied with spending £5000 of public money in paying his ignorant followers to make useless experiments. But that is not the way of our "unscrupulous" agitator. From this confused, heterogeneous mass of condemned and sup-

pressed experiments he picked just those examples, or bits of examples, that seemed to suit his views ; and then having, as a Commissioner, the power of calling witnesses before him, and also of sending out circulars of leading questions, he called the chosen band of "Clerks of the Works" before him, *made evidence* of their answers, and garnished his Reports with such bits and scraps from the replies to his circulars of unsuspecting correspondents, as agreed with his pre-settled *official* theory. This official theory and plan, which we shall have occasion to describe more particularly in our chapter on the "Rise and Fall of the Board of Health," may be shortly said to be founded on the following maxims or axioms as to administration and execution (*viz.*): 1. That the civil engineers who had executed the canals, docks, moleworks, railroads, tunnels, bridges, waterworks, and mining works of Britain were quite incapable of executing the works required for securing the health of towns. 2. That health works ought to be controlled by a board of briefless barristers and ex-doctors, garnished with a dilettante peer or two, and presided over by the inventor of Official Sanitary Reform, Edwin Chadwick ; designed by the plumbers, bricklayers, and "clerks of the works" who had graduated as sanitary engineers at the feet of Gamaliel Chadwick ; and executed by a corps of official sappers and miners, organised with the view of superseding private enterprise and eventually executing all public works, under direction of the Central Government Board. And as to the science and practice of hydraulic works, and especially street

sewers—1. That, scientifically, their dimensions had been calculated at too great a diameter by one-third (*which is not true*). 2. That in all cases glazed earthenware pipes of very small dimensions were to be preferred to brick sewers, on the ground that they were self-cleansing (*which is not true*). 3. That the glaze made the water flow more rapidly (*which is not true*), and that brick sewers were sewers of deposit (*which is also not true*). 4. That economy, increased capacity and velocity were to be obtained by a telescopic arrangement of sewers, gradually increasing in size from three, four, or six inches, to nine or twelve, and fed by as many branches as possible, like Pandean pipes fitted into trombones (*which is absurd*).

These theories, axioms, maxims, and recommendations were made “official” by being published as Board of Health reports and evidence; were circulated at public expense to the extent of many hundred of thousand copies; and then, when the suppressed fallacies had received the “official stamp,” whenever Mr. Chadwick made a speech, or drew up another report, or memorandum, or code of instructions for his tinkering and tailoring sewerage assistants, or whenever Mr. F. O. Ward elaborated a quarterly article, “leader,” or pamphlet, the wonderful tales of Lovick, Hale, and Medworth, of brickbats that rattled, and a live rat that came tumbling head over heels out of pipe sewers, are cited as dead and living witnesses against hydraulic engineers, and these cooked experiments are given as evidence of the ignorance and extravagance of engineers, and the ease with which expenses of

sewerage might be reduced two-thirds by reducing the size of sewers two-thirds.

Nothing could exceed the industry of these official coiners and utterers of scientific fallacies. For instance, at page 169 (Report of the Board of Health on the Supply of Water for the Metropolis, dated 1850), we find the following passages :—" At the commencement of this investigation no settled rules were found for the determination of the size and arrangements of waste or return pipes, or house drains for the removal of waste water." "On the appointment of the Consolidated Commission of Sewers for the metropolis, their consent was obtained for experiments on a limited scale." No one would judge from this paragraph that the expenses were many thousand pounds, or that the records had been suppressed by Mr. Chadwick himself. The report proceeds to give the evidence of " Mr. Medworth, the officer who executed the directions." After giving the various figure statements already alluded to as to flow of water, all perfectly absurd, the witness proceeds to state that sewage would flow *one-fourth* "more rapidly through red-ware pipes formed by pressure!" and further, that "Lambeth stoneware has an advantage over red-ware;" a little further he informs the willingly-credulous Commissioners, that "by putting branches on to the pipe the discharge might be doubled; he says, "the addition of another 4-inch pipe will increase the discharge from 84 gallons to 162 gallons per minute."

But Mr. Chadwick, who examined the witnesses—no one cross-examined them—was not satisfied with

getting a quart into a glazed earthenware Lambeth pint measure ; he must disparage scientific engineers, so he put this question :—

“Mr. Hawkesley’s tables are, I believe, taken as embodying the current and most recent formulæ (rules) before the institution of Trial Works, and were in practical use by engineers?” To which the docile Medworth replies very correctly, “Yes ;” but that his (Medworth’s) experiments (upsetting the conclusions of every eminent engineer from 1785 to 1850) had been verified by a variety of experiments, and tended, to use the words of Mr. Chadwick’s fishing question, “to the reduction of the quantity of water necessary to effect good cleaning, and render more manageable works of drainage, and much cheaper.”

Having thus dug up from the suppressed experiments exactly the evidence required, that evidence being totally false, Mr. Chadwick proceeded to report, “The old formulæ now in use are founded on imperfect data and experiments, and give results far above what experience shows to be the fact,” &c.*

And in the same year (1850) that the Board of Health made its more subtle attack on private enterprise and local government, we find in one of the Quarterlies the following popular misstatement from the pen of Mr. Chadwick’s late pupil and present rival, the ablest of his band of eager, hungry, adventurers, Mr. F. O. Ward :—

* Report of Board of Health on Water Supply of the Metropolis, 1850, p. 190.

"Mr. Hall experimented on a sewer in Upper George Street, Edgware Road, measuring $5\frac{1}{2}$ feet high by $3\frac{1}{2}$ feet wide, and receiving, by several tributary conduits, the whole drainage of about 44 acres. This great vein Mr. Hall proceeded to tie, as Magendie might tie a rabbit's. For this purpose he chose a point, only 560 feet above the mouth of the conduit; and where, consequently, its current was swollen by the collateral streams from the whole area drained. Here he built a brick wall across the sewer; leaving only a hole 1 foot in diameter for the passage of the stream. From this hole a pipe, 1 foot in diameter, was carried to the outlet; a distance, as we have said, of 560 feet. This portion, therefore, of the old vein, was virtually replaced by a new one, of less than a twentieth the former size, and about as big as an ordinary arterial water main. The results of this experiment were capital, and very curious. The original sewer had—like all its monstrous tribe—been wont to accumulate deposits, which were only partially kept under by incessant flushing. But in this 12-inch pipe no deposit whatever took place; a result attributable, of course, to the increased velocity of its closelier-pent stream. This, indeed, ran $4\frac{1}{2}$ times faster in the little conduit than in the large one; so that broken stones of several ounces weight each, when put in at the top of the pipe, were heard rattling along it, and speedily issued at the other end. Nay, when the pipe was flowing about half full, two brickbats, weighing $1\frac{3}{4}$ lb. each, were carried through its whole length, and emitted with such force from its mouth, as to strike the man who was watching for them a blow on the legs, which he declared to be painful. And a live rat, put in on the same occasion, came out at the lower end in so headlong a fashion, as proved him to have lost all control over his own motions."

The foolish persons who made, and the cunning person who quoted, this experiment, ignorantly or designedly overlooked the fact that by damming up the sewer with a brick wall, a head of water of extraordinary flushing power was created, and that in

effect the 1 foot pipe sewer was *pumped* clean ; they forgot that if, instead of a rat, a superior-sized tom-cat or two had found their way, as they often do, into the pipe, a choking up and flooding with sewerage water would have been the inevitable result, even without a storm of rain ; and sewers are made large to receive and prevent streets from being flooded, as well as to allow rats and cats to swim away.

Since 1850 the earthenware pipe has been very much improved, and its merits in its proper place, when properly manufactured, and its uses, under the conditions mentioned at p. 17, fully recognised ; while its defects, its liability to cause enormous expense and fearful nuisance, as a sewer of deposit, has been proved again in London, at Sandgate, at Croydon, at Southampton, and a score of other places sewered by Mr. Chadwick's own engineers. Nevertheless, having in view, no doubt, the pension gained, and place and pension to be gained, by setting up "*Official*" authority against practical scientific experience, to this day Mr. Chadwick and his friend, Mr. F. O. Ward, quote their "Clerks of the Works," and circulate the great discovery that the engineers and philosophers are stupid fellows, and that a quart can be put into a pint measure by using an earthenware glazed pipe of *Lambeth manufacture* !

CHAPTER IV.

METROPOLITAN COMMISSIONS, 1849-1854.

IN endeavouring to give our readers an idea of the sewerage theory which has proved so profitable in Place, Pension, and C.B.-ship to Mr. Chadwick, and so onerous to the unfortunate towns which came under his rule of thumb, while he was the presiding ruler of the late Board of Health, we have gone a-head a few years and must for a moment retrace our steps.

In 1848 Mr. Chadwick succeeded in creating the Board of Health; up to 1849 the Commission of Sewers and the Board of Health worked together most amicably, like the two kings of Brentford smelling at one nosegay. Experimenting, speechifying, lecturing, reporting, and promising, in fact, enjoying those happy moments which have shone upon the launching of plausible bubble speculations from the time of the South-Sea schemes to the last application of Berdan's apparatus to a Welsh gold mine.

The first Commission of 1847, as before observed, included four peers, two celebrated geologists, the Queen's physician, Dr. Southwood Smith, Dr. Arnott, nine M.P.s, one being Joseph Hume, a naturalist, and the greatest physiologist of the age, a reverend mathe-

matician, and other less celebrated names, but not one engineer.

In 1849 it was considered necessary to issue a new Commission, increased to thirty-nine Commissioners. This included two Royal Engineer Captains, two Cambridge mathematicians, the Astronomer Royal, and, as members for the City, the Lord Mayor and Aldermen, and three Common Councilmen.

This Commission, toward the close of its career, discovered the absurdity of the hydraulic experiments, as before described, and put an end to the trial works experiments on the ground of great cost and no useful results.

The attention of the public having been called to the condition of the Thames, which increasing population and the modern system of water-closets, opening into sewers instead of dry cesspools, had polluted to a serious extent, the Commission advertised for plans for the complete drainage of the metropolis. More than 150 plans were sent in, two or three ingeniously imagined, but not one sufficiently practical for execution. The rest included every shade of absurdity.

Two systems of dealing with sewerage came distinctly into competition, the Interception and the Sump System. Mr. Phillips proposed to convey all the sewerage of London into one great tunnel to pass under the Thames to some distant region or uninhabited shore. As this scheme, right in idea but impracticable in details, was afterwards dropped, there is no need to say more about it.

The other was the GREAT SUMP System of Mr.

Austen, founded on a delusion, not yet entirely exploded in spite of eight years of failures, that liquid sewerage could be made a source of sufficient profit to pay for the expense and costly machinery of distribution. We shall examine this question in more detail in our chapter "On the Value of Town Sewerage."

Among the many committees into which the Commission divided itself (on almost every one of which Mr. E. Chadwick's name is to be found) was "The Sewage Disposal Committee," which, like the "Trial Works Committee," contributed some evidence. Bits of this evidence, stamped with "official authority," have done duty for the last eight years. But at the end of the eight years the believers in large rent from liquid sewerage are dependent on £50 a-year paid to Rugby, and, in fact, not so far advanced as when Mr. Austen brought forward his plan. In this plan he proposed dividing the metropolis into districts, erecting in each a great cesspool or Sump, converging the sewers of each district to its own Sump, erecting a steam-engine with a tall stalk to do the double duty of ventilating the sewers and pumping the liquid sewerage into the country, there to be sold to gardeners and farmers at a price which, according to the faith of the Sewerage Disposal Committee, was to repay the whole cost of the metropolitan drainage and water supply, and leave a handsome surplus for public gardens, fountains, puppet-shows, and similar luxuries.

The magnificence of the engineering and liquid manuring ideas of Mr. Edwin Chadwick and his friends may be judged from the following extract

from an advertisement published by the Commissioners of Sewers in May and June, 1848, in which—

“Proposing by means of powerful steam-engines and appropriate pipes or channels to convey to a considerable distance from the metropolis all the sewage of that district, and being now engaged in various preparatory surveys and trials, and intending also that this large amount of sewage shall be so delivered as to be most conveniently and permanently employed for the purpose of irrigating arable soils and meads; they are now desirous of receiving proposals from the owners or occupiers of lands situated within *say 50 miles of London*, who are willing to contract for a supply of the liquid sewage, say in quantities per acre, if for water meadows, equal to 250 tons for each irrigation, and at the rate of 18 irrigations per annum. It is proposed to give the preference to those districts where (*as in the neighbourhood of Newmarket, or the valley of the river Crouch, in Essex, or that of the river Darent, in Kent, or that of the river Itchen, in Hampshire*) the population is widely dispersed, and the natural drainage, if into the Thames, falls into it below London.”

The proposal to deliver sewerage *fifty* miles from London appears not to have been received with favour by the agriculturists interested, although Mr. Cuthbert Johnson, F.R.S., a Commissioner (one of the faithful followers of Mr. Edwin Chadwick in London, and afterwards Chairman of the Local Board of Health at Croydon), in the pages of the “Farmers’ Magazine,” July, 1849, “earnestly entreates the great landowners, whose lands are situated within the circle to which this important advertisement alludes, to promptly examine the question, and quickly direct their conditional offers to the Commissioners.”

This celebrated advertisement is among the many

suppressed documents of the "Quart into Pint School," as well as the Report of the Sewage Disposal Committee. Mr. Chadwick's friends do not like to own that they ever patronised such an engineering absurdity as the sale of London sewage water at Newmarket. What the agriculturists did not support, the metropolis stoutly opposed, the residents unreasonably objected to a series of gigantic cesspools (they are now called sewageometers), and to the steam-engines and chimneys, and so the pump system was extinguished. Mr. Austen retired to the Board of Health, and under the unpopularity excited by the squabbles between the advocates of pumps with fifty miles pumpings and the advocates of the big tunnel under the Thames, the second Commission was dismissed and a third Commission sealed October 8th, 1849.

This Commission included, for the first time, some men really capable of understanding, weighing, and deciding upon a great practical engineering question, as, for instance, Robert Stephenson, M.P., James M. Rendel, S. Morton Peto, and Philip Hardwicke, the eminent architect; and if the Commission had been limited to these gentlemen, with the assistance of the five City Commissioners, the Lord Mayor, Alderman William Lawrence, Walter Peacocke, Edward Harrison, and Henry Lowman Taylor, who were sound men of business, might have worked out and executed some practical and extensive plan in spite of the encumbrance of Mr. Edwin Chadwick's nominee and chairman, Lord Ebrington,

and such Royal Engineers as Colonel Alderson and Captain Vetch, of whose peculiarities we shall have something to say presently. A competently educated engineer in chief, Mr. Frank Forster, was appointed. The schemes for protecting the Thames from pollution, sent in answer to the advertisements of the previous Commission, were classified and arranged by two of the sub-engineers, and reported on by Robert Stephenson, James Rendel, and three military engineers. None of them were practicable, and Mr. Frank Forster was instructed in November, 1849, to prepare plans for the main and intercepting drainage of both sides of the Thames. "In August, 1850, he laid before the Court a scheme for the interception of the sewerage from the south side of the Thames, which was approved and ordered to be executed at once."* At a later period of the year Mr. Forster was instructed to prepare plans for the northern side of the river, including the City of London, "and that he avail himself of the assistance of Mr. Haywood in that duty." The Northern Report was laid before the Commission on the 31st of January, 1851, with plans and estimates.

But the Chadwickian party now installed at the Board of Health, which as Commissioners of Metropolitan Sewers had only succeeded in making a series of absurd attempts at experiments and an enormous printing bill, was at work to impede the labour of their practical and educated successors. This, the first

* Report of the City Members of the Metropolitan Sewers' Commission, 6th November, 1855, upon the progress of measures for the Interception of the Sewerage of the Metropolis.

competent Commission, was effectually debarred from doing the great work needed by want of funds, while in the details of metropolitan street and house drainage it is difficult to say whether the influence of the military engineer or the civil noble amateur was the most mischievous—Vetch or Ebrington.

It was not to be expected that men engaged in extensive private practice like Stephenson, Rendel, and Peto, could do more than consider the reports of their engineer in chief, in whose capacity they had perfect confidence. This duty they performed, and placed the reports on the Thames interception in such a condition that, had the necessary funds been placed at their disposal, had they not been thwarted by the unprincipled intrigues of the official party, by this time the work would have been executed, London drained thoroughly, and the Thames as pure as the river of a great port can be. But Lord Ebrington was the head of the Commission of 1849—according to the rule that in the Crimea sacrificed our cavalry to Earls Lucan and Cardigan, and, at home, made Panmure inevitable and Frederick Peel indispensable as War Ministers.

At that time Lord Ebrington was 31 years of age, and had been in Parliament eight years; he had been apprenticed to office as Private Secretary to Lord Melbourne, and from 1846 to 1847 was a Junior Lord of the Treasury. When he ceased to be Chairman of the Commission of Sewers he became one of the Secretaries of the Poor Law Board, resigned his office on a point of salary, and has never since been

employed, although constantly before the public as a candidate for popularity. His last feat was bolting wholesale the pledges necessary for becoming the representative of Marylebone. Thus, the son of an Earl (to whom the Whigs owe a deep debt of gratitude), after fifteen years of public life, during the very period that Disraeli, Cobden, Bright, Lowe, and Layard have made their parliamentary reputations, with every advantage in birth, fortune, connection, and education, he has taken permanent rank with such parliamentary bores as Shelley and Manners, Adderley and Newdegate. Handsome, fluent, and vain, accomplished, envious, weak, obstinate, and meddlesome, Lord Ebrington perfectly realises the character which the Duke of Wellington so happily bestowed on a young peer of the same calibre: "My Lord, you have been educated beyond the powers of your understanding!" In 1849 he was just the kind of titled ornamental tool Mr. Chadwick so well knew how to find and use. The practical results of his chairmanship were "not a little curious," highly characteristic, but by no means "capital."

Mr. Frank Forster, the engineer in chief, was overwhelmed with real and with routine red-tape work. Beside the labour of designing the main and intercepting sewers, and other purely engineering responsibilities, the "*system*" introduced into the first consolidated Commission by Mr. Edwin Chadwick (one of those official systems which look beautiful in a report, and are perfectly unworkable in real business) consumed half the time of the chief engineer

in signing receipts or orders for sheets of blotting paper, bottles of ink, and boxes of steel pens, &c., &c.

The district engineers included the "Clerks of the Works" before mentioned; and Lord Ebrington, as a dilettanti pupil in Mr. Edwin Chadwick's new School of Sanative Engineering, condescended both to canvass private individuals for house-drainage jobs, and to instruct the district engineers on the proper mode of executing them.

Thus, for instance, when the imperfect drainage of a block of houses was reported to the Commission (and in those days there was plenty of need for such reports), his Lordship bargained with the tenants or owners that the private work should be done by his engineers, and the cost repaid by a rate or series of instalments spread over some thirty years. Few could resist so fair an offer, made by so good-looking a lord. But, lo and behold! when a great deal of private house drainage had been done on these *verbal* terms, it was discovered that the Commission had no power to give credit for instalments—proceedings were commenced for recovery of the scattered debts due for these private house-drains—and so Lord Ebrington lost his popularity with the ratepayers, and his character as a man of business with his fellow Commissioners. What made these disputes more acrimonious was, that his Lordship had not unfrequently settled the engineering as well as the financial details with equally unfortunate results. For instance, when a

plan for draining a block of houses was, as a matter of form, laid before him, he would suggest that some peculiar Chadwickian plan should be carried out—perhaps combined drainage; or “that it would be better, acting on the experiments of the ‘Trial Works Committee,’ that a commencement be made with a 3-inch pipe, gradually increasing to 4 inches, 5 inches, and 6 inches, on the telescopic principle—eh, Mr. Lovick?”

The result of these lordly interferences were repeated stoppings up, stinks, and re-laying; for there were few assistant engineers bold enough to contradict the wishes, forget the hints, or report the failure of plans of the Chairman, on whose good-will their bread and promotion depended.

But numerous as were the failures and the disputes during the period when Lord Ebrington combined the offices of Chairman and Engineering Autocrat over the metropolitan drainage, they were not, perhaps, one-tenth of those which became known years after Lord Ebrington had left the engineering, and tried and failed in another office.

We should have passed over the early mishaps of Lord Ebrington as the excusable results of youthful enthusiasm, had he learned wisdom, humility, and candour by experience, and shown himself ready to atone for his past follies; but it was due to public justice to illustrate at some length the public career of the nobleman who has recently lent all the influence of his rank and political connections to support

the malignant machinations and preposterous schemes of such an adventurer as Mr. F. O. Ward.*

In October, 1851, a new Commission was issued, from which Lord Ebrington's name was omitted, and, under a new Act, a paid Chairman, Mr. Edward Lawes, a barrister, was appointed. At the same time, by the influence of Mr. Chadwick's parliamentary friends, the powers of the Commission to raise money were reduced to a rate not exceeding 3*d.* in the pound; a sum quite inadequate for executing anything in the shape of a comprehensive main-drainage plan.

Messrs. Stephenson, Cubitt, Rendel, and Peto, devoted themselves earnestly to forwarding a great main-drainage and intercepting plan; but the street business of the Commission fell chiefly into the hands of the military engineers, and especially of Captain Vetch, a gentleman of whom it may safely be affirmed that he has never meddled with civil engineering, either in Westminster or Norfolk, without making a lamentable exhibition of his total incompetence for the task.

Captain Vetch, as a Commissioner, decided that the great Victoria Sewer should be, not excavated, as their chief engineer designed it, along public streets,

* With the "Open sesame" of Lord Ebrington, Mr. F. O. Ward was able to break through the usual labyrinth of forms of the great Circumlocution Office, and ransack the archives of the Admiralty (unsuccessfully as it turned out), for the purpose of damaging an engineer who had refused to become the slave of Messrs. Chadwick and Ward's empirical schemes. Lord Ebrington even went further, and to serve his sewerage party wrote letters which, had they found their way into the hands of a jury, would have placed him in a very unpleasant position.

but tunnelled under public buildings. The Royal Engineer Commissioners prevailed. The difficulties foreseen by Mr. Forster, who unfortunately yielded his judgment to official authority, accumulated. The Victoria Sewer works failed, and became the source of enormous expenses, for which Mr. Forster was most unfairly held responsible. At the same time he was subjected to a series of public and even parliamentary personal attacks, organised and circulated through the public prints by the official quart-intopint party, whose schemes and fallacies he had exposed; he was even accused of having assumed the reputation, antecedents, and testimonials of some other engineer of the same name.

Such are the opposition tactics of the modern school of Sanitary Reformers—liquid manure and malignant slanders are their standing stock in trade.

Disgusted and worn out by the internal and external attacks to which he was subjected, in January, 1852, Mr. Frank Forster resigned his office, and soon afterwards died prematurely, the victim of the rancorous malignity of Mr. Chadwick's friends.

After the death of Mr. Forster, the chief engineership appears to have been put in commission for a time. But the Commissioners found ample occupation, while the intercepting drainage plans were under consideration, in repairing and re-making the "cheap and nasty" work of house drainage, executed and boasted of so loudly by the first and second consolidated Commissions over which Mr. Chadwick ruled. Drains made, "like Peter Pindar's razors," not "to sell," but to be

described and quoted as models of economy and efficiency, failed by whole streets at a time. A sign of these failures may be found in an order of the Court, 29th of October, 1851: "That the surveyors were to report weekly all cases of obstruction of sewerage, and the form, size, material, and substance of the sewer or drain in which they occurred." And in April, 1852 (in consequence of the repeated failure of combined back drainage), it was ordered that, as a general rule, a separate drain should be constructed for each house.

In April, Mr. Lawes, the paid Chairman, died, and was succeeded by Mr. (now Sir) Morton Peto, the Vice-Chairman, until the appointment of another paid Chairman, Mr. Jebb. Mr. Thwaites, in a pamphlet published just before his election to the chairmanship of the Metropolitan Board of Works, ironically observes: "Here was the right man in the right place, and the public immediately felt the benefit of it." We say *ironically*, because Sir Morton Peto has always shared the opinions and supported the views of educated, experienced engineers—of Cubitt, Stephenson, Rendel, Hawkshaw, Hawkesley, Bazalgette, and Haywood, and has always treated the empirical theories of Mr. F. O. Ward, and the rest of the Quart-into-Pint School, with as much contempt as so courteous a man could. Mr. Thwaites himself * has

* Can it be that the late parochial radical and lay preacher Thwaites considers it prudent to except from his attack on the supporters of educated engineers the wealthy Baronet who so liberally contributes to the chapels where the Chairman of the Metropolitan Board of Works acquired a pious and not unprofitable reputation?

from first to last been a thick and thin supporter of Chadwick, Ward, Doulton, and the Lambeth stone-ware pipes.

In the same pamphlet Mr. Thwaites ingenuously observes : "Sir Samuel Morton Peto could not afford to give up his valuable time to the service of the Commission, and his good sense having ceased to counsel his colleagues," &c.

We are shocked to find so pious a man telling such a story as history, in the face of contradictory evidence. For Sir Morton Peto said, in the House of Commons (21st June, 1852), "That neither Mr. Stephenson, Sir W. Cubitt, nor himself, had any idea of taking the Thames as a means of sewerage ; but they had felt it their duty to resign, because there was no prospect of their being permitted to carry out the works they considered of urgent necessity. The Act under which they were performing their duty was so imperfect that no party could safely make a loan which he had negotiated, to be repaid by a small rate spread over 30 years." And Sir W. Cubitt and Mr. Robert Stephenson, in reporting on a ridiculous Syphon Scheme, allude to the parliamentary intrigues that gave them office without power, in a concluding paragraph, where they observe, "*As members of a former Commission, all the efforts of ourselves and those with whom we acted were crippled by events which we do not deem it proper to describe.*"

After the resignation of these gentlemen a reconstruction of the Board was of course inevitable. Accordingly, in July, 1852, a fifth Commission was

issued, which also included some thoroughly practical men, as, for instance, John Hawkshaw, an engineer of eminence, and specially experienced in the sewerage of towns; George Baker, a builder and contractor of the first class; Henry Hunt, the surveyor and land agent of Parliament Street; and, as with the three previous Commissions, some thorough men of business, the members of the City Sewers Commission.

By this Commission Sir William Cubitt and Mr. R. Stephenson, Commissioners under the two former Commissions, were appointed consulting engineers, and at a later date, Mr. J. W. Bazalgette was appointed engineer in chief.

It was in 1852-3 that the great London Drainage Company deposited plans and proceeded to Parliament for powers to execute a scheme of drainage interception, combined with a manufacture of sewage into manure, and claimed, on the asserted merits of their plan, a guarantee of £3 per cent. on part of their outlay, to be paid out of the sewers rates. On this scheme, Messrs. Bazalgette and Haywood, with the other engineers before mentioned, reported to the Commission, and gave evidence before the House of Commons; and it was very properly thrown out, because it would have charged the public not only for doing in a very incomplete manner a very small part of the work wanted, but because it would have very effectually prevented any really complete scheme from ever being executed. Indeed the engineers employed by the unfortunate amateurs who promoted the scheme were quite unequal to so great a task.

In the meantime the engineer, Mr. Bazalgette, of the Commission, and Mr. William Haywood, the engineer of the City Sewers, had been directed "to remodel the plan prepared by Mr. Forster, so as to accord with the views of the consulting engineers of the Commission"—making use of a mass of additional local information that had been obtained since the date of Mr. Forster's report.

While thus engaged, the working Commissioners, like their predecessors, found ample occupation in examining and remedying the experimental work and slop-work of the first and second Commissions.

It was found that a large amount of cheap work done by Mr. Chadwick's favourite engineers required to be re-executed, and especially that the pipes supplied had been in many cases of miserable workmanship, too large in diameter, too thin in substance, ill-shaped, ill-burned. They had been, for cheapness, roughly joined in hastily-dug tunnels; that they had been applied where, for want of fall or flushing, or both, deposit was inevitable. In fact, it was plain that works reported as models of cheapness were likely to turn out a perpetual charge on the ratepayers for repairs.

To put a check on the system of hiding the defects in pipes by burying them, the Commissioners adopted a series of rules, among which was one, on the motion of Mr. Baker, regulating the thickness in proportion to the diameter, and another rule limited the use of pipe sewers to lengths not exceeding 500 feet—two regulations for which the need was urgent. Indeed,

we may trace the perfection to which the manufacture of earthenware pipes has now been brought, to the severe test of these resolutions.

The manufacturers of stoneware pipes in Lambeth were, however, highly indignant, and soon afterwards a society was organised, a close alliance formed, between the official "Quart-into-Pint" men, on the one hand, and the Lambeth "Pipe-at-any-Price" men, on the other. But of this alliance we shall speak in a separate chapter on "The Stoneware Kings of Lambeth."

In January, 1853, in consequence of the perpetual demands upon the funds of the Commission for the repair and relaying of pipe sewers, which, according to the "Official Blue Books" of the Board of Health, were cheap in first cost, eternal in duration, and, above all, "self-cleansing," the Commissioners ordered their engineer to examine and make a report on such a number of pipe sewers as to be able to come to a conclusion on the question of under what circumstances are earthenware pipes to be preferred to brick sewers?

A summary of the result of this examination will be given in our chapter on the "Board of Health System of Town Sewerage." It is enough to state here that the report, which was laid before Parliament, showed that pipes had been laid down in more than a hundred places where they were quite out of place, and that they had consequently failed, and proved sewers of deposit, ineffective, and more costly than brick sewers.

This Report was very damaging to the "Board of Health," which was then seeking, not only for a renewed term of existence, but also to absorb metropolitan as well as local government; and it was also very offensive to the Lambeth pipe manufacturers, who naturally considered that there could not be too many failures as long as they were re-laid in silence, with new pipes of their make.

Therefore we find Mr. John Thwaites writing, at a time when he was patronised by Mr. F. O. Ward (who introduced him into the genteel society of the lords and philosophers of the Chadwickian School in Cork Street), and who in the last Commission represented the Lambeth Pipe Party, now represented by Mr. Frederick Doulton, that the "examination was commenced in the night (night in italics), and in the absence of and unknown to the district engineers;" and insinuating (pious man!) that the engineer executed some *hocus pocus* for creating the 122 failures he reported.

The *night* story was not true: the sewers were opened at the usual hour, early in the morning, when there was the least traffic about. Mr. Thwaites knew this from the explicit explanation of the engineer, but he professed not to believe a gentleman. The non-notice to one of the sub-engineers, Mr. Grant, a client of Mr. Chadwick's, was true. It had been remarked * that the pipe sewers under Mr. Grant's

* In London, the Cardiff Deputation saw Mr. Rammell, who referred them to Mr. Grant, surveyor of the Kennington District.

"Mr. Grant took us," the deputation relate, "to various places in that neighbourhood, where we saw the earth removed, and pipes exposed.

control always ran clear water when he received notice from his friends of the Board of Health that a deputation was coming to examine the small-pipe system; and as sewers do not usually flow with pellucid streams, it was thought advisable to avoid the chances of Mr. Grant's over-zeal for the self-cleansing qualities of the earthenware pipes of his patron, host, and friend, Mr. Doulton. Curiously enough, the pipes reported flowing by Grant were found clogged with deposit in his absence. But more of this presently.

At this period, 1854, the powers of the Board of Health were about to expire, and the Bill for the renewal of their autocratic powers was under the consideration of a Committee of the House of Commons. To counterbalance the unfavourable report of

Some of the pipes were disconnected to enable us to see their action, and we perceived water in a nearly clear state flowing freely through them. On reflecting that such could not be the usual condition of a drain, we examined the gardens of the adjacent houses, and found that the water was let on."

Pipe sewers examined and reported as full of deposit in 1853, were quite clean when Mr. Ward and Mr. Grant examined them in the following year. This seemed odd; but it is explained when we find that—

"A month after my (the engineer's) examination, I learned that Mr. Grant had constructed three flushing-shafts in the line of this sewer, and that his examination was made just below one of these shafts; and he has stated at the foot of his diagram that these pipes could, at any time, be instantaneously flushed out throughout their whole length; but I was surprised upon accidentally discovering that, within four months after his examination and statement, a considerable length of this very sewer, only 50 feet above the point examined by Mr. Grant, had been taken up and re-laid, having been stopped up with deposit, and the houses flooded in consequence."

We cannot help agreeing with the Cardiff inquirers, when they say, "*We were impressed with the conviction that our inspection was not of a casual or accidental character, but that arrangements had been made beforehand for our coming.*"

the engineer of the Metropolitan Commission, letters or reports were obtained from the local engineers appointed by the Board of Health, and the contractors under them, describing in the most glowing terms the economy and success of the small-pipe system in Sandgate, Rugby, St. Thomas's, Exeter, Barnard Castle, and other small places, then recently executed. These reports and letters were brought under the attention of Lord Palmerston, then Home Secretary, who forwarded them, with a significant hint that they deserved attention, to the Chairman of the Metropolitan Commission.

The Commission thereupon directed their engineer to proceed to the towns named, and examine and report upon their sewer and water-work arrangements. He did so accordingly, and the examination proved the total failure of the Board of Health system, as we shall in a special chapter relate.

Then Mr. F. O. Ward came for the first time on the stage, as a candidate for Mr. Chadwick's falling mantle, and on the 17th February, 1854, addressed to Lord Palmerston, who was then Home Secretary, a letter containing the following paragraphs:—

“The Commissioners of Sewers and the Board of Health are at issue as to the cheapest and best way of draining houses.

“The Board of Health advocate the drainage of each house block by tubular sub-main running behind the houses, and receiving the sewage of each by a short tubular branch. They recommend a large reduction of the sizes of drains hitherto employed; for the single-house drain, they recommend a 4-inch pipe; for a sub-main, receiving several of these, a 6-inch, gra-

dually expanding to 9, 12, and so on, up to 20 inches, as the lengths of the sub-main and the number of branches received by it increase. Such drains, they say, are self-scouring; the run of water through them is so concentrated that it keeps them clear of deposit; the branches being very short, and running backward towards the drain behind, instead of forward beneath the houses, towards a sewer in the street, have a quicker fall, and in case of leakage, leak into the open air, not into the houses; while the cost is so much reduced by this method, that blocks of labourers' houses may be thoroughly drained, and fitted with sinks and soil-pans, for an improvement rate of less than 2*d.* per house per week.

"The Commissioners of Sewers, on the contrary, recommend large brick sewers under the street in front of the houses, beneath each of which they carry a long drain from back to front, strictly forbidding more than two houses being relieved by one pipe drain; a system which, whether otherwise good or not, certainly entails an enormous increase of expense on the house-owners, and thereby redoubles the resistance on their part to sanitary improvement.

"The Commissioners of Sewers allege against the Board of Health plan, that any stoppage of the tubular sub-main exposes all the houses higher up to suffer, and renders it necessary for workmen to enter private back yards to search out and remedy the evil: they also deny the self-scouring property of the tubular sub-main, and refer, in support of their view, to several hundred cases of stoppages in tubular drains collected in a report of Mr. Bazalgette.

"The Board of Health, in reply to Bazalgette's report, bring forward examples by hundreds, of pipe sewers working admirably year after year, and attribute such stoppages as have occurred to errors incidental to the first introduction of a new system—errors which, once known, may be avoided. They say, that many of the tubular sewers, put down as failures in Bazalgette's report, are, at this moment, working perfectly well."

Lord Palmerston thereupon ordered a letter to be written to the Chairman of the Metropolitan Commis-

sion, inclosing Mr. Ward's letter, and stating "that it was his lordship's opinion that the system of drainage recommended by the Board of Health was that which ought to be adopted as combining the greatest degree of efficiency with the greatest degree of economy."

On this the Commission did what it was intended they should do—resigned; "not considering it consistent with their reputation, or with the best interests of the public, that they should continue in office" after an expression of opinion by the Secretary of State for the Home Department, in opposition to the principles and practice of the Commission, sanctioned by the highest engineering authorities of the day."

On the resignation of the whole body of Commissioners, with the exception of the paid Chairman, Mr. Jebb, the successor of Mr. Lawes, another Act of Parliament created a new kind of Commission, composed partly of representatives elected by the electoral districts of the metropolis, and partly of nominees. In this Commission, dated 22nd November, 1854, Mr. Frederick Oldfield Ward's name appears as a Commissioner, and also that of Mr. Cuthbert Johnson, who distinguished himself by his liquid manure theories in the first and second Commissions, and also as Chairman of the Croydon Local Board of Health. Mr. Thwaites was returned for the Lambeth and Southwark district, under the combined influence of the dissenters and Lambeth pipemakers; and Sir John Shelley was enabled to give an additional instance of his incompetence for any real business as a Commissioner of Sewers.

CHAPTER V.

THE SIXTH COMMISSION OF SEWERS, 1854, MR. F. O. WARD,
LORD PALMERSTON, AND THE EARL OF SHAFTESBURY.

PEOPLE who knew Lord Palmerston's character, who knew him to be a proud man, endowed with no ordinary amount of common sense, particularly shrewd in the management of his own affairs, preternaturally acute in detecting a quack or humbug, wondered at finding him corresponding with and patronising such a person as Mr. F. O. Ward—a style of person whose advice he would *not* have taken on the question of draining his Broadlands estate, or managing his Tremadoc slate quarry, or his Hampshire racing stud.

But the probability is that Lord Palmerston, being a thorough party man, is prepared to surrender any question about which he is ignorant or indifferent to gain a political point or to serve a friend. Now the Earl of Shaftesbury, a good man, sincerely anxious to see the people clean and virtuous, but always led by the nose by some one, because he has vigour without any original talent, married the daughter of Lady Palmerston, and thus became connected with two Whig families, although bred a Tory of the old school.

Lord Shaftesbury was early caught by Mr. Chadwick, has been one of the most indefatigable dittoes of the Board of Health, and has consequently become familiar with the literary apostle of the Quart-into-Pint School, Mr. F. O. Ward. When the Board was ignominiously routed before the House of Commons, by the break-down of their engineering works all over the kingdom, F. O. Ward stepped into the breach, and offered, if his noble patrons would support him, to carry the war into the enemy's country. At that period it was no small matter to secure the political support of so thoroughly respectable a man as the philanthropic Earl.

We can fancy that before the issue of the correspondence given in the last chapter, something like the following dialogue might have taken place between the jaunty and jocose Palmerston, and the pious and persevering Shaftesbury:—

Palmerston.—"Well, Shaftesbury, I have seen your friend—this Mr. Ward—had him for nearly an hour, and could scarcely get rid of him. Clever fellow, decidedly, but a fearful bore, and a good deal of a snob. Not quite so fatiguing as our old *cauchemar* Chadwick. Now, tell me, what is it you want me to do for him?"

Shaftesbury.—"My dear Palmerston, you do talk in such a singular style. You know I never ask patronage on personal grounds, and I can assure you that Mr. Ward is perfectly disinterested (*Lord P. laughs gently*), but we are anxious to put an end to the shameful system of engineering extravagance." Here

Lord S. launches into a Chadwickian harangue, during which Lord P. closes his eyes and meditates. From time to time the words, "imperméable glazed tubular," "sanative precautions," "cholera," "hygienic studies," "waste of sewage manure," "centralised authority," &c., rise above the level of the harangue. Lord S. finishes with "prejudices and ignorance of engineers." Lord P. starts from his musings, saying, "Capital, excellent, quite eloquent, my dear Shaftesbury; that would have done capitally in the House of Commons. I am afraid the Peers, dull dogs, would not sit through it: but to business. About this sewerage affair, I can't make it out who's right or wrong, and I don't mean to try. In fact, I don't care a hang about it; and as long as the London constituencies don't make up their minds I shan't. I've other things to think of. I wish, with all my heart, you'd ask for something better, and for yourself. However, as you want to provide for this Ward (Lord Shaftesbury makes a sign of dissent)—no—well, you want to advertise him then; let the man write such a plausible letter that I can send and get rid of the present Commissioners, and then I'll put him in. If he succeeds, of course sooner or later he will come in for something, although Chadwick has licked the sanitary dodge rather clean—C.B. and £1000 a-year, eh? But, mind, if he fails, I've done with him. I can't march through Coventry with a sewerage hobby. You ask me—I consent; he shall have a fair chance. If Cubitt and Stephenson's party should prove too much for

him—and they are heavy metal to go against, let me tell you—you must not expect any help from me, mind. I'm not a sanitary reformer mind!"

At this stage his Lordship's own man comes in, and whispers something. "What!" breathes Lord P. softly in reply, "honest John passing through . . . See him! course I will . . . Hope to goodness he's got another Ilione filly. Shaftesbury, excuse me; a tenant from Hampshire, very important."

So the Earl retires to put in motion the F. O. Ward Commission, and made room for honest John Day—honest Iago!—a Commissioner of another kind!

And now, before saying anything about the Metropolitan Commission which preceded Sir Benjamin Hall's parochial parliaments, we must give a little sketch of Mr. F. O. Ward, the Feargus O'Connor, the Cabot, the Louis Blanc of Sanitary Reform, to whom we have more than once referred. At present he is rather under a cloud; having left the more profitable trade of praising himself to libel some one else, and as the boys say, "missed his tip," and besmeared himself, he is obliged to be silent, for fear of being hooted down. But there is no doubt that so ingenious and industrious a gentleman will make himself heard again when he thinks the world has forgotten his little malignant eccentricities.

Mr. F. O. Ward, educated a surgeon, soon ceased to practise, and took service as a clerk to the late Joseph Hume, M.P., an excellent school for acquiring

and systematising the kind of knowledge likely to be useful in a public career. By Mr. Hume, during the existence of the first Metropolitan Commission, he was recommended to Mr. Edwin Chadwick, and became one of the "able hands" employed by that gentleman to preach up the new theories of engineering founded on the experiments of the Trial Works Committee. In the course of this duty he wrote a number of very popular articles, in which he set vividly forth the defects of existing institutions, and in a very distinct manner propounded a plan for putting all the public works of Great Britain under the control of one central Board, composed of the new legal and medical school of sanitary reformers. He also speculated in small patents (many an unsuspecting tradesman paid dearly for infringements on forgotten inventions), and finally became known as an agitator and London drainage projector.

An able writer, a persevering speaker, or rather reciter of his own pamphlets, with a special talent for claptrap phrases, and the faculty of rapidly acquiring and employing, when addressing an uneducated audience, the technicalities or hard words of any science, he has been working hard to succeed his tutor and patron in the power, patronage, and profits, which, until pensioned, Mr. Chadwick exercised and enjoyed as "The Board of Health." Not that Mr. Chadwick has by any means retired on his £1000 a-year from active life, but, like the retired tallow-chandler, he only works now for pleasure.

Mr. F. O. Ward has no engineering experience—

his mechanical talents are just sufficient to enable him to invent a patent flexible-backed brush; his scientific acquirements are of the quality to be acquired by a sharp man from "Scientific Dialogues for the Use of Schools." He began to study hydraulics (the most abstruse branch of engineering) when he became a drainage agitator, and he knows just enough of the higher branches of arithmetic and mathematics to astonish and puzzle those who know nothing;* but he has two qualifications which serve him well—courage and connection. His courage is worthy of the lively Frenchman who contradicted the great lawyer Romilly on a point of English law, saying, "You are wrong, my dear Romilly; I read it yesterday in Blackstone." Mr. Ward, at a moment's notice, would undertake to instruct General William Napier on military and Sir Edmund Lyons on naval tactics, Sir David Brewster in optics, and Professor de Morgan in mathematics. When Jack Wilkes, who began as a demagogue and ended as Chamberlain of London, was told by an opponent that he would take the sense of the meeting against him, he answered, "I will take the *nonsense* of it, and beat you by two to one." That is Mr. F. O. Ward's plan.

As long as Mr. F. O. Ward was an ex-surgeon, writing articles explaining Mr. Chadwick's quart-into-pint theory, suing unfortunates for infringements on his patents, and instructing tailors on the proper

* Criticising very confidently the hydraulic calculations of an engineer, he observed one day, "I have checked them algebraically." If he had said astrologically, there would have been just as much sense in his observation.

mode of managing a water-closet, no one paid any special attention to his amateur theories; but when, from cramming Lord Ebrington, the Earl of Shaftesbury, and Sir John Shelley for parliamentary sanitary displays, he advanced to be the nominee Commissioner of Lord Palmerston, then people who had never thought about the subject before very naturally took it for granted that Mr. Ward must be a man of distinguished scientific abilities, if not an eminent engineer. He has had the prize—he must now bear the penalty of having the ignorant presumption of his official career exposed.

And Mr. Ward lost very little time in justifying the expectations of his ignorant friends by producing for the drainage of London a plan of gigantic absurdity.

He began at the beginning and advanced to the most difficult branches of the profession with astonishing rapidity.

For a few weeks he studied the rudiments of practical engineering under the clerks of works, very willing to teach a Commissioner. From them he learned to distinguish “a gradient” from “a level,” the meaning of the word “invert,” and the capacity of “a cubic yard of earth;” with commendable industry he dived into excavations and penetrated deep sewers, asking questions and making notes like a zealous, intelligent reporter, and in a few weeks he found himself competent to snub Cubitt and correct Stephenson, and give instructions to the Engineer of the Board.

The sixth Commission, as before mentioned, was

only sealed on the 22nd of November, 1854, when Mr. Ward's *practical* acquaintance with engineering commenced; he was then, to use his own expression in open court, an *apprentice*; but on the 22nd of January, 1855, we find, from the records of the Court of the Commissioners, he had an interview with the chief engineer, in which he explained his (Mr. Ward's) proposals respecting the main drainage of the metropolis.

"The leading features of the scheme were the separation of the surface or rain water from the house drainage, by having one set of sewers and house drains to carry off the rain waters, and a duplicate set of sewers and house drains to carry off the house drainage or sewage. *He proposed a new description of pavement for the whole of the London streets*; the sewers to be free from sediment. Mr. Ward stated that this could only be effected by the *sewers having a fall of 1 in 300, which fall he proposed to obtain by the aid of pumping*. On the north side of the Thames he proposed to have three lines of intercepting sewers, similar in plan to those suggested by Mr. Haywood and Mr. Bazalgette, into which the branch sewers falling from north to south were to discharge. In each line of intercepting sewer were to be three pumping lifts of 60 feet each, or nine lifts of 60 feet for the north side. Mr. Ward considered this scheme would only *cost about two millions more* than the plan of Mr. Haywood and Mr. Bazalgette."

We may note here, that Mr. Edwin Chadwick, although he forced the "quart-into-pint drain" theory on every population where he had power, and although he made most unscrupulous use of "*prepared evidence*" and "*cooked experiment*," always carefully avoided committing himself to any

specific plan for any specific place. Indeed, he did very well without ; he earned in a very few years, power, patronage, a pension, and the C.B. riband. Mr. Ward, coming second, must jump higher and dive deeper to get the same honours and profits out of sewage ; hence he committed himself to a plan.

This plan is founded on a theory which he is fond of explaining, by comparing the sewage of London to "mines of Peruvian guano, unworkable in consequence of floods of water," and "to be turned into cash for the benefit of the ratepayers, by keeping separate drains for sewage and for rainfall." We may observe in passing, that there is no sort of analogy between guano and night-soil : the guano being the best manure for corn, roots, and grass ; while liquid sewage, in a much stronger form than it can ever be delivered, may do for grass, but would be utterly destructive to corn, and much too weak for roots.

But Mr. F. O. Ward is like the gipsy who has discovered a treasure in the farmer's orchard—"If the farmer's wife will only give her a ten-pound note, five gold sovereigns, half-a-crown, a sixpence with a hole in it, and a clean damask napkin to wrap the coins up in, the treasures shall be hers in a fortnight." Make him drainage dictator, and the profits shall be counted in millions.

He begins by doubling the drainage of all existing houses, in order to make combined back drainage as well as area drainage.

That at £5 per house for the second drain, would cost, on 300,000 houses	£1,500,000
Then under or over the 1000 miles of brick sewers, which are to be reserved for rain, 1000 miles of tubes at a low estimate, £3000 per mile	3,000,000
Then the second sort of tubes along the 400 miles of brick sewers now required, will come to	1,200,000

Making a grand total of £5,700,000

Beside the cost of the intercepting main drains, say two millions sterling.

Then come the pumping expenses. This would require steam-engines of about 18,000 horse-power, costing for plant £1,500,000; and for annual cost of working and repairs at the water-works, estimated £20 per horse-power, or £260,000 a-year.

According to Mr. Ward's scheme the street works are doubled, with the double difficulty of excavating over or under the brick rain sewer; and if a sewage sewer under a brick sewer should stop up, the difficulty may be imagined. His combined house drainage scheme stops up the drainage of all the houses from No. 2 to No. 10, if the cook with her fat, or the maid with her hair-combings, forgets her duty to herself and her neighbours. It requires two sets of pipes, one for the back, and the other for the front area drainage, and two sets of perpendicular pipes, one to carry the rain and the other to carry

the sewage to the street. This complication will in most cases be a source of endless expense and continual broils, especially where there are children or careless or spiteful servants—and where are there not some of these in a street? There are cases in which combined drainage may be adopted with advantage, but quacks like Mr. Ward drain as Sangrado bled his patients.

In the principal streets of the metropolis, the perpetual changes in the character of property make combined works unadvisable. A private residence with stables becomes a shop or a manufactory; new cellars are required, every yard of land is wanted, and the joint-stock pipe sewer stops the way until the owners of the whole block are of one mind. In fact, the Board of Health, ruled by the mind of a routine official, had one rigid empirical rule for all cases, nominally economical, practically the source of incalculable and endless expense in repairs and alterations. Engineers, with a reputation to lose, fit their works to each separate case.

We cannot calculate the incidental expenses of re-ripping up 1000 miles of streets, or the perpetual blockades, examinations, and repairs, which must occur when a dead cat, a bullock's heart, a handful of lady's hair, or a bundle of stolen napkins, is enough to stop up a street sewer!

But we must do Mr. Ward justice, and admit that he had a per contra in millions to be gathered, whenever farmers imitate Mr. Mechi, and pipe their farms, and pay 2*d.* a ton for the stuff. He has

adopted all the theories of the Board of Health, and boldly applied them to London.

His talent for claptrap is displayed in the following sentence, which he ingeniously introduces on every possible occasion :—

“All the rainfall due to the river,
All the sewage due to the soil.”

It sounds very pretty, like Dr. Johnson’s parody on

“Who rules o’er free men should himself be free”—

“Who drives fat oxen should himself be fat.”

But it means that ratepayers should spend a sovereign in order to send a shilling’s worth of London guano into the country.

In the interview mentioned, Mr. Ward requested the Engineer to lend him his assistance in working out this gigantic absurdity. Of course the Engineer declined to lend himself to any such folly ; thereupon he was threatened with the future opposition of the Crown Commissioner, and with a “Parliamentary Inquiry.”

During the remaining career of this Crown nominee (whose engineering education had been commenced and matured in fifteen months), his voice and pen were constantly occupied in attacking and criticising the plans of the most experienced and scientific engineers of the age.

And this is the gentleman who receives the steady support of Lord Palmerston, the Earl of Shaftesbury, and Lord Ebrington ! What a specimen of the qualities deemed worthy of Crown patronage and parliamentary support ! How long would any really origi-

nal inventor be in forcing his way through the great Circumlocution Office?—Ask the inventor of the screw propeller, the builder of light-draft steam-driven gun-boats, and a crowd of able disappointed men.

But these honours would not have given Mr. F. O. Ward the position he required to do the utmost amount of mischief; he would not have been able to control and thwart the Engineer, and, in imitation of Lord Ebrington, force a fallacious system of drainage and sewerage upon certain districts, if he had not been supported by the representative of a powerful, consolidated, centralised, commercial interest—the Lambeth Pipe Association.

The sixth Commission, which lasted from November, 1854, until the Metropolitan Management Act came into operation in December, 1855, contained a powerful and active minority identified with Mr. Chadwick's school, intent on counteracting and avenging the defeat which the Board of Health had suffered in that year.

During the years 1850, 1851, 1852, and 1853–4, the influence of Stephenson, Rendel, Peto, Cubitt, Hawkshaw, Henry Hunt of Parliament Street, and George Baker of Lambeth, with the steady assistance of four thorough men of business in the City Members, did much towards repairing the cobbling experiments of Mr. Chadwick's first two Commissions, and executed new work in sewers and house drains to the amount of nearly half a million of money with the most complete success.

Under the force of compulsion and competition the Lambeth manufacturers produced a very superior article in stone-ware pipes, which was with advantage substituted for brick in house drains, and also reasonably employed in streets.

A complete plan for main drainage and intercepting would have been commenced and far advanced, had not the intrigues of the Chadwick, Ebrington, and Wardian party, anxious for office, interposed financial difficulties.

The sixth Commission was intended to be, and to a certain extent was, a reactionary movement against science and experience, in which professional agitators retailed, garnished with claptrap, the technicalities they had crammed from fifth-rate engineers.

Next to Mr. F. O. Ward in prominence was Mr. (or, perhaps while we are writing these lines, Sir) John Thwaites, a woollen-draper and lay preacher in Southwark—a solemn, white neckclothed, deep-voiced, fluent, plausible parish orator, with little education, but a great deal of talent, and that useful kind of knowledge of business that a clever man picks up in a retail trade. Had he also picked up a notion of the value of impartiality, courtesy, and accessibility in office, we should have been spared the pains of sketching him.

In an historical point of view the sixth Commission is chiefly remarkable for the liberality of its orders to printers and the length of its debates. One Commissioner made some experiments on the effects of his house sewage on his grass-plat. There was no

thing new, strange, or original in the facts or results; however, after contributing them to a gardening periodical, he was allowed to reprint them in a neat tract, as a Commission document, at the ratepayers' expense. Then another Commissioner asked the opinion of a Mr. Law on the intercepting plans prepared by Messrs. Bazalgette and Haywood and approved by Messrs. Stephenson and Cubitt, the said Mr. Law being quite incompetent even to understand the *formulae* or rules used in the hydraulic calculations; in fact, it was like taking the opinion of Mr. Paul Checkerbent, one, &c., on the joint opinions of Sir Richard Bethell and Sir Fitzroy Kelly. Nevertheless, at the metropolitan expense, Mr. Law's criticism, with coloured plans, was printed and circulated.

Then Mr. F. O. Ward found every week something to print and advertise his own merits and the low opinions he, the projector of the seven million pumping scheme, had of the Engineer, and always found a Shelley or a Thwaites to support him.

Here is a short statement of the way in which the time of the Commission was absorbed in purposeless orations, while Lord Palmerston's nominee persecuted the Engineer for not adopting and licking into shape his amateur pumping plan for the London sewerage :—

On the 22nd of January, a speech from F. O. Ward, in which the Engineer's answer to the first question was designated as a "gross blunder."

On the 23rd, a long speech and attack on Mr. Bazalgette and Engineers in general.

On the 30th, another attack, on presenting a certain absurd and libellous memorandum, printed at metropolitan expense.

On the 20th of January, Mr. Ward moved that the Engineer should reproduce his calculations, and hinted that he had improperly "destroyed them to keep them out of view."

On the 27th, Mr. F. O. Ward brought a charge against the Engineer of gross blunders in his levels (they were not the Engineer's levels, but the Surveyor's), and the Committee decided that there were slight imperfections in the *lithographing* of "no importance!"

On April 17th, when the Engineer presented his detailed calculations, Mr. Ward called them "confused and disgraceful," "for which a clerk in an engineer's office would have been dismissed;" and objected to the Engineer being heard in his own defence! [These very calculations were not only satisfactory to the Court, but pronounced by Robert Stephenson clear, ample, and correct.]

On September 4th, another personal attack on the Engineer. When he attempted to defend himself, Mr. Ward "protested against his being heard, as he was only in the room *on sufferance*."

On September 18th, Mr. Ward attacked the Engineer, in a long speech, accusing him of furnishing calculations "to deceive the Commissioners;" and on the 2nd of October, pledged himself, in another speech, to prove that the calculations were intended "to throw dust in the eyes of the Commissioners."

On the 9th of October, Mr. Ward charged the Engineer with "suppressing a court document;" and on the 16th, made a general attack on his competence and integrity.

On the 23rd, he gave notice of a string of charges against the Engineer for the next court day, and stigmatised him as the organ of the class interests of the Civil Engineers.

And in September, in a speech of three hours, he accumulated his attacks on the personal reputation of Mr. Bazalgette under pretence of moving for a committee of mathematicians to examine the formulæ of Mathematical Engineers.

On the 8th day of November, Mr. Bazalgette replied, and was supported by a majority equal to two to one.

Mr. Ward, having a great personal object to gain, persevered week after week in delivering, at every meeting of the Board, carefully-prepared speeches (in spite of public and private warnings of his total misconception of the subject), in which professional incompetence was broadly charged, and personal untrustworthiness ingeniously insinuated, against the Engineer of the Commission—on the authority of Mr. F. O. Ward, witness; by Mr. F. O. Ward, Commissioner, in order to forward the plans of Mr. F. O. Ward, projector of a rival London drainage scheme. Thus uniting in his own person the incongruous characters of prosecutor, counsel, witness, judge, and jury, he got up the evidence—made a speech for the prosecution, to which, according to official rules, there could be no reply—passed sentence—and then,

as his own reporter, forwarded the *ex parte* judgment to the *Observer* and other journals favoured with his confidence.

We print, as a kind of brick from his Temple of Malignity, Mr. F. O. Ward's resolutions side by side with a letter from Mr. Robert Stephenson, addressed to the *Times* newspaper of the 6th November, 1855, and leave our readers to judge between this quack adventurer and the first of living engineers.

"Mr. F. O. Ward will call attention to the present position of the main intercepting drainage question, as represented in the various reports and documents before the Court, with particular reference to the data and calculations of Mr. Bazalgette, as to size, slope, and rain-discharging power of the proposed tunnels, and as to their consequent magnitude and cost. In the course of his remarks, Mr. Ward will have occasion to advert to the course taken in that controversy by Mr. Bazalgette, and by this Court. In controverting the views and calculations of Mr. Bazalgette, Mr. Ward will feel it his imperative duty, not only to point out engineering inconsistencies, entailing, as Mr. Ward believes, important errors of design and serious waste of public money, but also to show that Mr. Bazal-

"SIR—I cannot permit the attack made by Mr. F. O. Ward (at the special meeting of the Metropolitan Commissioners of Sewers on the 30th ult.) on Mr. Bazalgette, Engineer of the Commission, to pass without remark.

"Mr. F. O. Ward, in this last of a series of attacks of the same nature, endeavoured to show—

"1. That the plan prepared by Messrs. Bazalgette and Haywood, and approved by Sir W. Cubitt and myself, for diverting the sewage of London from the inhabited banks of the Thames, is founded on wrong principles.

"2. That the engineering details for carrying out those principles are badly, unscientifically, and extravagantly arranged.

"3. That the information in facts and figures supplied by Mr. Bazalgette is not to be

gette's data and calculations, as set forth and applied by him, tend to disguise those inconsistencies, to baffle investigation, to perplex and mislead the Commissioners, and to prevent the formation of a clear judgment as to the magnitude and cost of the works required for the main intercepting drainage of the metropolis."

depended upon—that it is, in fact, obscure and incorrect.

"These are questions of a character so purely scientific and technical, involving hydraulic calculations of such intricacy, that they can only be appreciated and understood by professional men. I venture to say that it is quite impossible that the Commissioners, or the mass of the public who read the report of

Mr. F. O. Ward's speech, could have understood the bearing of any part of his arguments, except the positive assertions which he made.

"I shall not enter into any discussion on these, which are among the most difficult points in my profession, with Mr. F. O. Ward; but I wish, before I leave England for some weeks, to state publicly that I have not assented to the great intercepting drainage plan as a matter of course and without due investigation.

"This plan was prepared and submitted to me as a Commissioner, by Mr. Frank Forster, in 1850-1; it has since been altered and improved by the extended experience of Mr. Bazalgette, and Mr. Haywood, the Engineer of the City Sewers, who have given their attention to it for more than three years.

"Every detail has been submitted to Sir W. Cubitt and myself; the levels have been most carefully taken by Mr. J. Smith, the Surveyor of the Commission.

"Each part of the whole plan has been separately and conjointly deliberated and reported on by Sir W. Cubitt and myself. At least three of these reports have been printed by the Commissioners of Sewers.

"I have personally checked all the calculations; the formulæ or rules used in making these calculations are those accepted by every engineer of hydraulic reputation; of their accuracy I have no manner of doubt.

"I am therefore prepared to be personally answerable for the soundness of the principles and the accuracy of the details of the London Sewage Intercepting Plan which Sir W. Cubitt and myself have approved as Consulting Engineers; and I beg leave here to express in the most decided manner, my full confidence in Mr. Bazalgette's professional skill and personal integrity, as well as my opinion that he has furnished the Commissioners with all the information which he was bound to furnish.

"With respect to Mr. Ward, I had an opportunity a few months ago (at the house of a friend of that gentleman) of expressing to him my opinion of the character of his objections to Mr. Bazalgette's plans and calculations. I told him then that I could characterise his objections as nothing better than puerile. I adhere to that word.

(Signed) "ROBERT STEPHENSON.

"24, Great George Street, Westminster,
November 2."

When the Commission came to a close, and Mr. F. O. Ward became an ex-Commissioner, he first tried to be elected a member of the Board of Works; having failed there, he personally canvassed and called a meeting of all the new members at his own rooms, which, however, was attended by only two or three, with the view of recommending himself for the office of Chairman of the Metropolitan Board: the proposal having been coldly received even by those whom he had been commercially serving, with admirable perseverance and energy he devoted himself to canvassing for his fast friend, Mr. John Thwaites, and with the assistance of the compact Committee of Pipe Manufacturers, described in our next chapter, defeated in detail a band of respectable opponents, each

fighting without organisation on his own hook, and elevated the parochial orator of Southwark to the chairmanship of the Metropolitan Board of Works, at a salary of £1500 a-year. Was ever parochial oratory so well rewarded?

Having succeeded well so far, Mr. F. O. Ward did not slacken, but set to work to supersede his old enemy the engineer by setting up against him Mr. Rawlinson, a favourite engineer of the defunct Board of Health. Mr. Ward had capital allies and fellow-canvassers. The Government influence was placed at his disposal; he was allowed to use the Admiralty telegraph; Lords Shaftesbury and Ebrington worked with him; the new Board of Health was one standing Committee, the Lambeth pipe men provided another; money was not spared; the item for Hansoms must have been something considerable; while the wheels of Doulton's phaeton, bearing the great Ward himself, rolled night and day.

But this time the plot failed. The Board of Health man was beaten ignominiously, although in his speech, with characteristic modesty, he told a story showing how much cleverer he was in the matter of culverts and embankments than Robert Stephenson. F. O. Ward relieved his mind in the *Times*, by a thirty pounds advertisement, abusing Mr. Bazalgette. In minor elections he was, however, more successful.

The two engineers, Mr. Grant and Mr. Cresy, who had assisted him to worry their chief, were both provided for. Mr. Cresy, who had lost his situation as engineer some time previously, in consequence of the

total failure of his engineering works at the Ravensbourne and elsewhere, was made nominally clerk, really private secretary to the Chairman, Thwaites ; a good appointment, for Mr. Cresy writes well, and that part of the Chairman's education has been neglected. Mr. Grant was appointed assistant engineer. The grateful Lambeth manufacturers could do no less for their staunch friend.

We do not profess prophetic powers, and cannot, therefore, venture to guess how the present Board of Works will work ; we prefer giving the opinion of Mr. F. O. Ward, written in 1850, when he was already preparing to turn his aristocratic connections to profit, and become one of "a Metropolitan Board of Sanitary Works, composed of half a dozen suitably paid Commissioners," of "sound," that is, Chadwickian, "views on sanitary subjects." Mr. Ward thought that—

"The proposed new parliament of parochial delegates would be but a colossal Board of Guardians, or a dilated Common Council ; more mischievously powerful as an organ of political passions, but equally incompetent to superintend the complex sanitary organisation of a great city. This parish parliament would be composed chiefly of tradesmen, unskilled in the problems of sanitary engineering. This unpaid, fluctuating, heterogeneous assemblage could not, in the nature of things, succeed ; but, like the parochial portion of the late Sewers Commission, it would make speeches instead of doing work. Its vaunted responsibility to the ratepayers would be so weakened by subdivision and discontinuity, as to be rather nominal than real. On the parish hustings, indeed, *political motives* would have more weight than sanitary considerations. Nor would hustings pledges, in the new any more than in the old

corporation, guarantee the ratepayers against jobbing and speculation. Under such influences, extravagant expenditure would alternate with equally extravagant parsimony."

Whether this prophecy will prove true we leave to the consideration of Mr. F. O. Ward's two fast friends, Mr. John Thwaites and Mr. Frederick Doulton.

CHAPTER VI.

THE STONE-WARE KINGS OF LAMBETH.

THE elections for the vestrymen of Lambeth, under the Metropolis Management Act, gave a clue to a mystery that has often puzzled those who have watched the eccentric career of Mr. Chadwick's sanitary successors. Where, was a question often asked, do Mr. F. O. Ward, and the "self-cleansing glazed pipe theorists," find the means for carrying on an organised agitation in favour of the Croydon system of town drainage? Parliament has extinguished Mr. Edwin Chadwick's Board of Health, with its hand in the public purse, its army of obedient inspecting engineers and surveyors, and put an end to the circulation of scientific fallacies, and engineering falsehoods, at public expense. Who pays for the printing and posting, and clerks, and canvassing, and cab hire, and advertisements of a column and a half in *The Times*, directed by the ex-Commissioner Ward? When the parish of Lambeth has returned seven

pipe-makers to the Lambeth Vestry and one to the Board of Works, seven gentlemen who had previously, with two exceptions, refrained from the agitation of parish business—seven gentlemen pledged (in justice to themselves and to each other) to lay down as many pipes as possible in the parish works under their control—when the phalanx of seven sent the able chief, the directing spirit of the glazed pipe trade, the great advocate of civil, religious, and commercial liberty in everything but pot-pipes, Mr. Frederick Doulton, to represent Lambeth in the Metropolitan Board, thus elevating him from his previous position, bowing humbly to contractors, soliciting orders for pipes, to awarding contracts in the Metropolitan Council Chamber, while his brother partner bowed below—when Mr. Doulton, delegate for the pot-pipe interest, was seen furiously driving about, with Mr. F. O. Ward seated at his side, hurrying, scurrying the metropolis through to secure votes in favour of a chairman, a secretary, and an engineer, pledged, as they hoped, to the quart-into-pint theory, exhausting every electioneering trick, and expending no small amount of money, in order to exclude from power those who were either impartial, or experienced, or educated—the murder was out; it was the Lambeth-pipe manufacturers who supported the “pipe-at-any-price party.”

How Mr. F. O. Ward was paid we could not ascertain, whether by empty praise or solid pudding; but this was certain—no commercial ambassador ever better deserved a handsome commission; and if

the Lambeth men do not come down handsomely, now that their pet has been so cruelly excluded from the regulation of the London sewers, why, they are very ungrateful men.

The transformation of the seven Lambeth potters into seven Lambeth vestrymen caused us to search the reports of the Greek Street Commission, and there we found that this new-born parochial zeal was stimulated, not so much by any necessity for bolstering up the consumption of pipes (for the utility of sound, well-made pipes, within certain sizes and limits, is a fact which has never been disputed), as by the dread of what the French call the "invasion of the foreigner." Mr. F. Doulton approves, it seems, of open competition in bread, beef, and religion—but not in pipes. A thin gray pamphlet, printed for the Commissioners, tells the whole story.

It seems that the Lambeth Pipe Manufactory is carried on under great disadvantages; the goods are bulky and the premises are small; the site of the potteries was, in part, originally occupied by glass works, which were extinguished by the competition of glass made close to cheap coal, and in part by a coarse pottery manufacture, which was gradually raised to importance by a very skilful production of vessels for containing and distilling acids for chemical purposes, and bottles for gin and ginger-beer.

It seems, too, that since 1848 two manufactories of glazed drain and sewer pipes, tiles, ornamental bricks, and architectural ornaments, have been established on some beds of very superior clay, commonly called

terra-cotta clay, near Aylesford, on the river Medway, the very place where the Romans manufactured some of their famous pottery. At the Aylesford and Burham Potteries—there being of course ample space—the best mechanical contrivances for grinding, mixing, and moulding the clay and sand, brought by short tramways from the adjacent pits, have been adopted. Under these circumstances, as might be expected, the Kentish potters, although they do not compete with the Lambeth Pottery in manufacturing vessels of the highly-burned, semi-vitrified quality necessary for distilling or holding boiling acids, can and do produce everything in the way of bricks, pipes, and tiles, glazed and unglazed, equal in strength and durability, and superior in form, to the Lambeth goods, and at least 10 per cent. cheaper.

The first step of the Lambeth potters, when the Kentish wares were introduced into the London market, was to try to crush them by an underselling competition. For some time the public had the benefit of a reduction of 30 per cent. on the present prices; but the Kentish Potteries were backed by too large a capital to be so defeated. The next step was to form an association, which appears to have had a double object: to resist an order from the Metropolitan Sewers Commission for increasing the thickness of pipes used in sewers, and for raising by the power of combination their price generally. Some time previously the Commissioners of Sewers, annoyed by the repeated fracture of long lengths of thin or ill-burned pipe sewers, had adopted a resolu-

tion increasing their thickness. This increase was furiously protested against in Lambeth.

To the Kentish potters the increase was of less consequence; they had not 11s. a-ton to pay for clay whether used or spoiled, and the quality of their clay gave facilities for increased thickness.

Moved, then, by these or other motives, an association was formed, and still continues, on the principle in part described in the following "Private and Confidential Circular."

"(Private and Confidential.)"

"At a Meeting of London Potters, held at the Bridge House Tavern, Southwark, on Friday, the 23rd September, 1853, at eleven o'clock in the forenoon:—present—Mr. W. Batstone, Mr. Thomas Cookes, Mr. Doulton, Mr. J. Doulton, jun., Mr. H. Doulton, Mr. S. Green, Mr. James Harris, Mr. Millichamp, per Mr. M. Chambers, Mr. D. Montague, Mr. W. Miskin, Mr. W. Northen, Mr. Alfred Singer, Mr. Thomas Smith, Mr. J. Stiff, Mr. C. White, Mr. G. Whitton, and Mr. Robert Williams.

"After some discussion, it was unanimously resolved—

"'1st. That, in consequence of the great rise in the price of coals and other raw materials, an organisation of London Potters is necessary, with the view of making a general advance in the price of manufactured goods, and of adopting such other measures as may be deemed desirable to meet the necessities of the case.'

"At an adjourned meeting of the London Potters, held on Tuesday, the 27th day of September, 1853, the Committee submitted their Report, which, after some modifications, was adopted as follows:—

"'That for the furtherance of the objects of the Society, and the government thereof, the following shall be fundamental rules:—

“ ‘ 1st. That this Society shall be called “The London Potters’ Association.”

“ ‘ 2nd. That all manufacturers resident within forty miles of the Metropolis, shall be eligible as Members.

* * * * *

“ ‘ 4th. That each Member shall pay an entrance fee equal to £1 per kiln, into the hands of the Chairman, and an annual subscription of £1, payable at the first half-yearly meeting.

* * * * *

“ ‘ 7th. That at any General or Special Meeting it shall be competent for any Member to propose a price for any article not included in the lists, and the same shall be added thereto, upon approval by a majority of the meeting.

“ ‘ 8th. That to secure the observance of the Resolutions of the Society, each Member binds himself in the penalty of £50, which shall be forfeited on any infringement, determinable by a majority of the Members at a Special or General Meeting.

“ ‘ 9th. That any transactions among the Members of this Association shall be subjected to an additional discount of ten per cent., but that no extra allowance shall be made for cash payments.’

“ Having proposed Rules for the general government of the Association, the Sub-Committee submitted the lists No. 1 and 2 as standard lists; No. 1 being the Stone-ware list, and No. 2 the Drain Pipe list, when the following resolutions were passed; as affecting the trade at the present period:—

* * * * *

“ With reference especially to list No. 2,—Resolved, 1st, ‘ That this list shall apply to pipes not exceeding the following thicknesses:—

3 in. 4 in. 6 in. 8 in. 9 in. 10 in. 12 in. 15 in. 18 in.
 $\frac{1}{8}$ $\frac{1}{4}$ $\frac{5}{8}$ $\frac{11}{16}$ $\frac{3}{4}$ $\frac{7}{8}$ 1 $1\frac{1}{4}$ $1\frac{1}{2}$ in.
 subject to a discount not exceeding ten per cent., but that a discount of $2\frac{1}{2}$ per cent. may be allowed for cash payments.’

* * * * *

“ Resolved, 2ndly,—‘ That for any pipes exceeding the thickness specified in the foregoing resolution, the following shall be the prices, subject to the same conditions:—

6 in.	9 in.	12 in.
9d.	1s. 4d.	2s. 6d. per foot.*
[Instead of 8d.]	1s. 1½d.	1s. 10d. per foot.]
*	*	*

“ Resolved, 4thly,—‘ That no discount, premium, or commission of any kind, shall be allowed to engineers, surveyors, or clerks of works.’ *

“ Resolved, 5thly,—‘ That if any misunderstanding shall arise with regard to the meaning of any of the foregoing rules and resolutions, reference shall be made to the Chairman and Secretary, and their decision shall be binding.’

“ After votes of thanks to the Chairman and Honorary Secretary, the Meeting was adjourned.

(Signed)

“ WM. MISKIN, Chairman.”

The Kentish Company refused to enter into this combination, that is, they refused to give up the advantage of their facilities for manufacturing cheaply.

For such audacity they were soon doomed to be punished. Some contractors, who had determined to use Kentish pipes in sewer works in the Lambeth district, found that the district surveyor refused to sanction the use of anything but Lambeth pipes. Now, it is to be noted that this surveyor was Mr. Grant, the gentleman whose sewer pipes in Lambeth appear, according to the report of a Cardiff deputation and of the engineers of the late Commissioners

* According to this resolution it would seem that such a custom had prevailed. That it has been relinquished we may be permitted to doubt, for reasons which will be stated in due course.

of Sewers, to have been always so clean when he showed them to Country Deputations, and so full of deposit when examined without giving him due notice.

The agent of the Kentish Pottery appealed to the Commissioners, and produced testimonials in favour of Kentish pipes of the most satisfactory character, from the most respectable builders and contractors,*

** Testimonials from Builders and Contractors.*

"130, Great Suffolk Street, Southwark.

"June 29, 1855.

"DEAR SIR,—In answer to your request, I have much pleasure in stating, that I used your pipes on the whole of the works at the New Cattle Market (above 20,000 feet), and found them in every way to my satisfaction, and to the satisfaction of the Architect.

"Dear Sir, yours truly,

(Signed)

"JOHN WILSON."

"3, Exmouth Street, Southampton, June 30, 1855.

"SIR,—In answer to your inquiry as to my experience in the use of your pipes, I beg to say, within the last three years I have used a large quantity of them, some thousand feet, and I have had experience in the use of all kinds of stone-ware pipes since they were first brought into use for drainage purposes, but have found yours the best, as causing the least waste by handling about, and therefore strongest. I had a number of truck loads to Southampton, and had not one broken.

"I am, Sir, &c.

(Signed)

"JOHN HENRY BROWN."

"Belvedere Road, Lambeth, July 3, 1855.

"DEAR SIR,—In reply to your inquiry, we have used very largely your drain pipes in works for the Commissioners of Sewers, and elsewhere, and have never heard a complaint, or had any of them rejected. Our experience in the use and manufacture of pipes has been considerable, and we believe it impossible to obtain any better than those made by you.

"We are, dear Sir, yours faithfully,

(Signed)

"LUCAS BROTHERS."

and from the eminent chemist Dr. Letheby (since elected Medical Officer to the City of London) a report containing the following passages:—

“ Apart from theory, it is known that some of the most ancient pottery in existence is composed of the very same elements, united in nearly the same proportion as we find them in Aylesford clay. The pottery, for example, which has been found in the ancient tombs of Egypt, and which has endured for at least 3500 years, is of this composition.

“ Again, the celebrated vases of ancient Greece, those, for instance, which are known as Etruscan vases, and the vases of the Campania, of which hundreds have been found in the soil of Greece, Italy, and the neighbouring countries; these, also, contain a large proportion of lime, and have a composition not essentially different from the clay of Aylesford. Some of these vessels are supposed to have been made before the time of Homer—that is, about a thousand years before the birth of Christ.

“ Then, again, the ancient Roman pottery contains in some cases as much as $18\frac{1}{2}$ per cent. of lime; but for all this, the vessels made of such a material were thought fit for domestic purposes, and have stood the influences of the soil for hundreds of years.

“ 1st.—Their structure is perfect in respect of chemical combination.

“ 2nd.—They are dense enough to ring, and are, therefore, homogeneous and tenacious.

“ 3rd.—They are porous enough to absorb water, and are, therefore, fitted to resist a shock.”

The Lambeth potters replied, in a letter which forcibly reminded one of the effusions by which protectionists of every country—silk and woollen manufacturers, and corn-growers in England, iron-masters in France, and cotton-spinners in Spain—have proved

conclusively that high prices and private combinations were as useful to the public as to the associations. With the letter were reports from a couple of chemists showing that Kentish terra-cotta pipes, like Carrara marble and Scotch granite, might be destroyed by boiling in muriatic acid—a fact which nobody can deny. The same reason would show that the sewer pipes should be constructed of platina.

These pot and kettle disputes would not be worth relating—they might safely be left to be battled out by the parties interested—were it not for the light that the discussion threw upon the sincerity of those Commissioners who claimed for themselves the merit of being economical and progressive reformers of sewerage works. Commissioners, who ought to have been judges, appeared as advocates; one sat with a model, supplied from Lambeth, before him, like a barrister advocate on a patent case. Mr. F. O. Ward, as warm in favour of the Lambeth combination and £10 per cent. advance as when recommending his own plan of draining London, declared that the Kentish pipes, which Cubitt found good enough for Buckingham Palace and Belgravia, were rubbish which he could scratch into holes with his nail. In fact, if Messrs. Ward and Co. were to be believed, the benefit of pipe sewers could only be obtained by supporting the monopoly of Lambeth pipes. Finally, the discussion was adjourned, for the Engineer to report, and then Mr. Ward and one of his fellow Commissioners—hoping that he will learn impartiality, we will not name him—with Mr. Grant, the model

Surveyor of the model pipe district, retired, to dine with a Lambeth pipe manufacturer. In due time the Engineer made a report, from which we extract the following paragraphs:—

“Pipes which are perfectly circular, are stronger and more to be depended upon than those which have been drawn by the furnace, or twisted into an elliptical form. For instance, a distorted pipe, assuming an elliptical form, placed between the blocks, with the flat sides vertical, would withstand much greater pressure than when placed with the flat sides horizontal; and this fact may, to some extent, account for one of Messrs. Doulton's pipes, which are frequently more warped in the burning than the Aylesford pipes, having broken under the more favourable circumstances (*i. e.* between circular blocks), in the first experiment, before it had received a weight of 32 cwt., and having afterwards, under the more unfavourable circumstances (*i. e.* between flat blocks), in the second experiment, withstood a pressure up to 32 cwt. 100 lbs.

“Subjoined tables show the sizes, thicknesses, amount of absorption, and breaking weights of the pipes in detail.

“From the first set of experiments it appears that the Aylesford pipes withstood in all cases greater weight than the Lambeth pipes; but, for reasons already assigned, I consider the experiment favoured the Aylesford pipes, and is therefore not decisive.

“From the second set of experiments, which I believe to have been the fairest to all parties, it appears that the average breaking weight of the Aylesford 9-inch pipes was 23 cwt. 15½ lbs.; Doulton's, 23 cwt. 15½ lbs.; and Stiff's, 19 cwt. 39 lbs. The average breaking weight of the Aylesford 12-inch pipes was 24 cwt. 15 lbs.; Doulton's, 32 cwt. 100 lbs.; and Stiff's, 24 cwt. 85½ lbs.*

* The 12-inch pipe of Doulton's, which bore 32 cwt. 100 lbs., differed entirely in colour and texture from the ordinary Lambeth ware, and bore a marvellous resemblance to the much stronger terra metallic pipes made by the same gentleman from Staffordshire clay at his works near Birmingham.

“ The Aylesford pipes absorb considerably more water than the Lambeth pipes ; this is owing partly to the inferior glaze, and greater porosity of the material of the Aylesford pipes, and partly to the ends and sockets being left unglazed for the purpose of forming a better cement joint.

“ I have not entered into the complicated question of the component parts of the different clays, and of the effect of various chemical agents which are generated by the London sewage upon the glaze of the pipes, considering it to be a subject rather for the consideration of the professional chemist.

“ The conclusions at which I have arrived may be thus briefly stated :—

“ That the Lambeth pipes are of a closer and stronger material than the Aylesford pipes, but that this advantage is counterbalanced by the increased substance of the Aylesford pipes, which renders them equally strong with the Lambeth pipes.

“ The Lambeth pipes are better glazed than the general stock of the Aylesford pipes ; a matter of considerable importance.

“ The Aylesford pipes are more perfect in form than the Lambeth pipes ; a very important advantage as regards the strength and self-cleansing properties of sewers.

“ The cost of the Aylesford pipes is about ten per cent. lower than the Lambeth pipes.

“ I am of opinion that if the Aylesford pipes are glazed equal to the Lambeth pipes, they ought to be admitted into the works of this Commission, in competition with the Lambeth potters ; and I am satisfied that by the adoption of this recommendation this Commission will tend greatly to the improved manufacture of the pipes, and benefit of the public.”

The Commissioners ordered this report to be printed ; and there the matter ended.

The friends of Mr. Doulton dug up an order of a previous Commission (*tempore* Chadwick), that the

sewers pipe should be salt glazed, and so the Kentish competition was stopped; that is to say, they were rejected when any small contractor wished to use them; but, at least on one occasion, when the great firm of Lucas Brothers took a contract for sewer work, the surveyor, Grant, objected in vain: the Lucas firm was too strong, and, after a faint struggle, he was obliged to permit pipes of Roman material, considered good enough for Belgravia, to be laid down in Camberwell. At the same time the simple Smiths, Browns, and Robinsons, who dared to go to the Aylesford Wharf to execute a contract over which Commissioner F. O. Ward had any control, soon discovered a marked man, and found it advisable to make his peace with the pot kings of Lambeth.

Now, this little history extracted from reports of debates and printed documents but scarcely published, enables us to trace and explain the connection between what the *Observer* newspaper, in a series of paragraphs which seem all to bear the stamp of the same "fine Roman hand," calls "Mr. F. O. Ward and the party of progress," and the Lambeth Potters' Association. The disinterested patriots who have been so anxious to save public money by substituting glazed pipes for brick sewers, are the same persons who won't hear of anything but Lambeth pipes; who object to competition, and approve of combination.

While F. O. Ward is officer, his adviser, his friend, his host, is a Lambeth potter. When F. O. Ward is out of office, the Lambeth potter takes his place.

Together they canvass, together they struggle to put in a secretary who shall be without prejudices, and, hand-in-hand, they work in favour of the Board of Health engineer.

We leave vestrymen and members of the Metropolitan Board to draw their own conclusions. Having made public the alliance, we need not cry out, as the police do in crowds, "Take care of your pockets;" but we may venture to ask Mr. F. Doulton, potter, of the Metropolitan Board, and Messrs. Henry Doulton, John Doulton, Stephen Green, Daniel Green, R. B. Williams, and James Stiff, all potters and vestrymen, how they construe the following clause of the Act under which they regulate sewers and water-closets:

"LIV. In case any member of the Metropolitan Board of Works, or of any District Board of Works, or of any vestry for any parish mentioned in Schedule (A) or (B) to this Act, or any auditor of the accounts of any such board or vestry, be declared bankrupt, or apply to take the benefit of, or become subject to, any Act for the relief of insolvent debtors, or compound with his creditors, or accept or hold any office under the board or vestry of which he is a member, or of whose accounts he is auditor, other than, in the case of any such auditor, his office of auditor, or in any manner *be concerned or interested in any contract or work made with or executed for such board or vestry, in every such case such person shall cease to be such member or auditor as aforesaid*; and any person who acts as a member of any such board or vestry, or as auditor of the accounts thereof, after ceasing to be such member or auditor as aforesaid, or who, being a shareholder in any joint-stock company, votes upon any question in which such company is interested, *shall for every such offence be liable to a penalty of fifty pounds*, which may be recovered by any person who may sue for the same in any of the superior courts of

law, with full costs of suit : provided also, that all acts and proceedings of any person ceasing to be such member or auditor, or disabled from acting as aforesaid, shall, if done previously to the recovery of such penalty, be valid and effectual to all intents and purposes whatsoever."

The Lambeth ratepayers will doubtless learn in due course that as nine make a quorum, and as eight potters have relations, doctors, and attorneys, it never will be difficult to make a quorum whenever a chance occurs of encouraging the local trade and working out practically the eternal proverb of "nothing like leather."*

* Since the preceding Chapter was written, Mr. William Haywood, M. Inst. C. E., engineer of the City Commission of Sewers, has in a very elaborate Report to his Board, dated 27th May, 1856, come to the conclusion—

"That as regards capability of resisting pressure and percussion, as regards sectional correctness of form, and smoothness of internal surface, the Aylesford pipes are well adapted for the purpose of constructing sewers and drains.

"That as regards their internal glazing, it is unimportant, as it affects the flow of water, whether it is improved or not.

"That as regards their porosity, it does not appear to me to be such as to constitute a tenable objection to their usage, under most circumstances, for sewers and house drains.

"And that in the absence of evidence as to the injurious effects of sewage water upon them, I should consider them to be sufficiently durable for the purposes intended."

CHAPTER VII.

THE RISE AND FALL OF THE BOARD OF HEALTH.

THE Board of Health, which from 1848 to 1854 exercised despotic powers over the water and sewer works of some hundred towns, distributing patronage directly and indirectly, immediately and prospectively, to the amount of millions—which very nearly succeeded in obtaining the management and monopoly of all the water works, sewerage works, and funeral ceremonies of the metropolis, was the legitimate offspring of the first Sanitary Commission for Inquiring into the Health of Towns. It was composed of one chief master-spirit, the lawyer, Edwin Chadwick ; one assistant medical ministering spirit, the doctor, Southwood Smith ; and two amiable enthusiasts and ornamental peers, Lords Morpeth and Ashley (now Carlisle and Shaftesbury).

Mr. Chadwick commenced his sanitary labours with the assistance of some very eminent names : with Dr. Arnott (who in 1854 reported the failure of the Chadwickian job at Croydon), with Professors Airy and Owen, De la Beche, the geologist, and Broderip, the naturalist. His scheme of small pipe drainage was a distorted copy of Josiah Parkes's plan of agricultural drainage ; and all he knew of water supply

was gathered from the evidence of Thomas Hawkesley, which (after picking such facts as suited his ulterior views) he suppressed, and only alluded to the authority in order to libel. His onslaught on intramural and scheme of extramural interment was borrowed almost verbatim from the works and labours of the gentleman so well known in the medical profession as "graveyard Walker." But the scientific and practical names fell from this Macbeth of sanitary reform when they found that their opinions were to be shaped into mere echoes of the lawyer's leading questions. One gentleman eminent in a scientific and practical profession was so fearful (not without reason) lest Mr. Chadwick should practise on him his ingenious system of "elegant extracts," and "cooked evidence," that when he received a set of questions from the Chairman to the Board of Health he went to the expense of printing his replies. In 1848 the Board of Health was created by Act of Parliament, and in 1850 Mr. Chadwick had been abandoned in disgust by all the eminent men of science and engineers by whom he was for a short time surrounded, and his followers were composed either of unsuccessful engineers, or of half-educated persons, breveted to the dignity of Civil Engineers on their assenting to all the absurdities of the "Board"—Edwin Chadwick.

The Board of Health started with an excellent foundation; for, although the inquiries of the Sanitary Commissioners were made with foregone conclusions (as the future employment of the reporters

employed depended on their finding plenty to regulate in the state of country towns), still there was ample proof that the majority of the towns investigated were deficient in sewerage arrangements, in water supplies, and in general regulations for securing cleanliness without and ventilation within dwellings, and that the mode of obtaining local Acts was both cumbrous and costly; the cholera, too, then raging violently, strengthened the hands of the officials, who undertook to preserve health by facilitating cleanliness.

Common sense would have suggested that to regulate the engineering arrangements of all England some more suitable coadjutors might have been found for Dr. Southwood Smith than a lawyer and two lords; that among the more eminent of our engineers, architects, and great contractors, some one might have been selected whose practical and scientific knowledge in dealing with brick and stone, excavations and tunnels, water and air, would have rendered him a safe pilot, a tame elephant for the lord, without whom it is very difficult for any Commission to inspire proper respect in country deputations. Engineers and architects, builders and contractors, are as susceptible of the promptings of ambition as other classes. You find them like other men expending precious hours in Parliament, on public business and philanthropic institutions, but they will not accept official responsibility without honorary reward, or consent to spend valuable time in deliberating without the power of acting.

But it is a curious fact that in this eminently practical country our Government always acts on the

principle that a peer and a lawyer are the only people fit for every post, and that the men who understand a *specialty* are only to be used as witnesses.

In the case of the Board of Health there were excellent reasons why no man of any practical experience should hold any authority there. Unanimity was desired ; unanimity was secured on the principle that Signor Catalani recommended for making up a concert, “*Ma femme, et deux ou trois poupées.*” Mr. Edwin Chadwick had new theories to carry out, and he had invented the Board ; he took care to name the Commissioners, so that he ran no risk of being contradicted in his experiments.

In the first Report of the Board of Health, dated July, 1849, we find the lawyer, the doctor, and the two peers reporting that “*In the local works which it is necessary to execute for the sanitary improvement of towns, an entirely new system of sewerage must be combined with a new system of house drainage, with a new system of water supply, and with a new system of removing and of applying the refuse of towns to agriculture.*”

The “*new system of sewerage*” was founded on conclusions from the suppressed experiments of Messrs. Lovick, Hale, Medworth, and Co., viz., that a glazed earthenware pipe would convey away one-third more fluid than the engineers and natural philosophers in sixty years’ trials had ever obtained ; that such glazed pipes were self-cleansing, and never needed opening for obstructions ; that such pipes need not be more than from 4 inches to 9 inches in diameter ; that the rainfall ought to be kept out of the sewer pipes.

The "new system of house drainage" consisted in providing separately for the rain water and domestic water ; in substituting, in all cases, water-closets for open privies ; and in combining blocks of houses in one back drain, by which, in certain cases (rarely in London), length of pipe was saved, at the risk of one accident stopping the drains of a whole row of houses ; and in employing pipes of 2 and 3 inches in diameter.

The "new system of water supply" consisted in abandoning rivers or springs as the sources, in favour of soft or rain-water, to be collected in "gathering grounds," valleys dammed up for the purpose, and led in earthenware pipes, at high pressure constantly on ; so that cisterns would become unnecessary in private houses, and water would always flow on the turning of a tap.

The "new system of applying refuse of towns to agricultural purposes" was founded on the theory that liquid sewerage was better than solid manure ; that it might be advantageously applied by the machinery of hose and jet to all crops ; and that, therefore, agriculturists would pay a rent for its use that would defray a material part of the cost of the sewers and water works. And local Boards of Health were recommended to inclose waste lands, "drain, and lay down upon it pipes for the distribution of the sewer manure, and then re-let it, prepared for cultivation, with the right to the supply of the manure on lease, and apply the surplus to the sanitary improvement of the town."

In these ideas, which eight years' experience and

the expenditure of hundreds of thousands of pounds have proved to be costly, wasteful, and the source of endless repairs (as we shall presently show by a list of cases from all parts of the country), there were germs of truth.

Josiah Parkes had successfully drained Fairford, a village of 39 dwellings and 170 inhabitants, at the top of a hill in Gloucestershire, with Staffordshire pipes, and he had also shown that agricultural land could frequently be drained of pure water (no hair, fat, or house flannel) with pipes 1 inch in diameter. Thomas Hawkesley had introduced into Nottingham the constant supply principle, so as to avoid the use of cisterns; and Paine, an eminent agriculturist of Farnham, had obtained for his little village a supply of capital soft water from "gathering grounds." Edinburgh and Mansfield supplied (very exceptional) examples of liquid manure application.

The work undertaken by the Board of Health was indeed gigantic, and required first-rate practical and scientific qualifications; but a retrospect of their works and their reports shows that it was from the first the object of the Board to establish a "new system," with "a new class of engineers of special qualifications," educated by, and dependent on, the "Board," and eventually an army of Government paid excavators and mechanics, so as to supersede educated civil engineers, and make Government do the work of private enterprise. And it must be admitted that no scheme could have been better planned for establishing the permanence and complete autocracy of the Board.

But although Ministers may be humbugged, Parliament bamboozled, and the press, for a time, crammed with cooked theoretical evidence—facts work their way, and truth prevails in the end; nature cannot be made drunk; all the powers of a “Board,” all the blue books, all the inspectors’ reports, will not make water run up hill, or put a quart into a pint measure. So, after a certain series of failures, the Board of Health broke down.

In 1850 Mr. Chadwick was radiant and triumphant, the system of self-praise had been carried to perfection. His ambition was not satisfied with regulating the provinces. “The Board” aspired to ruling over London. A celebrated “Report on the Water Supply of the Metropolis,” with some half-dozen appendices, opened the trenches, supported by a battery in the Quarterly article from which we have already quoted, and a dropping fire of rifle-shots from the daily and weekly press. The water supply of London at that time was deficient in quality and quantity,—why, we shall show in our “Water Chapter.”

The Board of Health went in boldly to claim the management of the water works, consolidated the execution of a scheme for “an entirely new supply of soft water,” and gaining courage on the way, ended by claiming the sole control of the street sewers, with compulsory powers to execute all the house-drains of the metropolis. Considering that every existing arrangement was, according to the opinion of the lawyer, the doctor, and the two peers, vitally wrong, the report of 1850 amounted to a recommen-

dation that the reporters should be allowed to re-execute the whole of the sewerage and water works of the metropolis, at a cost which we may venture to estimate at somewhere about ten millions sterling.

This was pretty well, but there are no bounds to the philanthropic despotism of such a radical reformer as Edwin Chadwick, and in due course he produced a report, stolen, without acknowledgment as to its telling facts, from "The Walker on Graveyards," showing the evils of intramural burying-grounds, the necessity of establishing cemeteries far removed from dense populations, which no one but Archdeacon Hales will deny; and then, with reasoning eminently Chadwickian, proposing that the cemeteries should be the property of the Government, and that all funeral rites, from the black scarves to the gravestone, should be the subject of a Government management,—of course under the control of the officers of the Board of Health.

The public, like an individual, is sometimes taken by surprise by a proposition of outrageous impudence, and, just as you have sometimes permitted a stray acquaintance to invite himself to dinner, supper, and bed, to kiss your maid, borrow your umbrella, and obtain your acceptance to a little bill, on the strength of his having paid 4*d.* for your omnibus fare, so Mr. Chadwick having made a reputation by exposing the want of sanitary reform in our streets and houses, got as far in his scheme of Metropolitan dominion as purchasing a couple of cemeteries; when metropolitan indignation, swelled by cries from the provinces of populations whom his model engineers had half-ruined

and half-poisoned, drove him into pensioned retirement, smashed his Board, and left him at leisure to be gratuitously mischievous on the voluntary principle.

Thus although eleven thousand copies of the Blue Books of the Board of Health, artfully distributed at public expense, did all that could be done towards vaccinating the public with the novel and absurd manure-and-water theories of their chief—and although he had a capital stock-in-trade to work upon in dirt which existed, a want of drainage that was plain to every unbiassed nose, a water supply that was woefully deficient both in quality and quantity, a system of parliamentary legislation on local improvements that was at once costly and absurd, without wanting advents and threatened advents of the cholera, Mr. E. Chadwick failed. Had he succeeded, he would have centred in his own hands irresponsible power and patronage, in comparison with which the combined patronage of the Chairman of the East India Company, the Commander-in-Chief, the Archbishop of Canterbury, and the Premier, would have been insignificant. But he failed for several reasons. Many people who hated dirt in every shape opposed him, because, although they were deeply convinced of the urgent need of sanitary measures, they were not at all convinced that to put the work in Mr. Chadwick's hands was the best mode of reforming. They saw that he was a lawyer, more fond, as lawyers generally are, of victory than of truth, obstinate in his prejudices, intolerant of opposition to his opinions, and as greedy of power as zealous for his mode of drainage,

water supply, and interment. In a word, no one was to be clean except by Chadwick's patent soap. There were persons who might have put up with a first-class engineer, but the lawyer-advocate Commissioner would not do. There were others who went further, and said, "Because matters are badly managed at present, that does not prove they would be better managed by substituting a Government Board for vestries or commercial companies. We can apply to Parliament, or the Home Minister, or the opposition leader, or the *Times*, to call vestries or public companies to account; we can compel them to publish intelligible accounts, and make water companies subject to summary penalties; but if every turncock wears her Majesty's livery, and every lamplighter has a direct appointment, and can defy his foreman, then gas and water delinquencies will become a question of ministerial confidence. No, let us have some one over the Boards that supply our water and construct our sewers, some power strong enough to put on the screw." "Besides," they argued, "if we are to be buried by Government because we spend too much money on our funerals, the next step may be to clothe us. Set Mr. Chadwick to work, and he will produce a Blue Book with such evidence of extravagance and improvidence—economy from buying wholesale, and improvement of taste in cut and colour by the help of Marlborough House (if two such stars as Mr. Edwin Chadwick and Mr. Henry Cole could consent to shine in the same constellation)—as will make a clothing board indispensable, and a clothing rate quite natural. Of

course clothing inspectors and surveyors, and annual reports adorned with coloured plates! An eating department might follow clothing—public kitchens at an economy of fuel and broth far exceeding even Mr. Chadwick's frustrated saving in soap. With this advantage in the cause of *public order*, clothed, dined, watered, lighted, and buried by a Board of Health, it would be a poor street that had not as a resident at least one Government officer, a tailor, a butcher, a cook, a lamplighter, water-bailiff, or mute, entitled to wear B. H. on his collar, and to be quoted by Mr. E. C. in an annual report as 'a highly intelligent individual, who gave evidence in favour of a centralised system of shaving and hair-cutting.'"

These, perhaps, were unworthy prejudices and suspicions, but there was a practical argument that helped to clip the soaring wings of the great chief of the Board of Health. The Board promised well, but performed ill; from Croydon to Sandgate, from Dover to Hitchin, from Folkestone to Southampton, you could track "the improved combined system," by its failures and by its extravagance; by estimates exceeded by 50 per cent., repairs never ending, pipes stopped up, populations poisoned with vile smells, the promised constant water supply most inconstant, in some towns not to be had at *night*, at others neither night nor day.

Of course there were excellent excuses for these failures; excellent reports were written by the Engineers of the failures, showing that they never occurred, and if they did, that they were of no consequence, and that

in any case the Board was not to be blamed. Writers of Blue Books do not smell bad smells, or feel thirsty, or suffer in purse for failures; but the public are obtuse and particularly uncharitable on the failures of great reformers. Monsieur Louis Blanc can explain why his Utopia failed, and so can Monsieur Cabot; but somehow people are not inclined to try MM. Blanc and Cabot any more. In the case of the Board of Health, the despotism of interference had been carried so far at Coventry, at Leicester, and at Croydon, and other places, that it was plain the Board—that is, Mr. Edwin Chadwick—did not mean any town to be drained, or sewered, or watered, unless the Board of Health rules were observed, and a Board of Health engineer employed, and the failure of the “specially-qualified” engineers reacted on the reputation of the Board.

This was one of the many instances of a fine position and most comfortable berth (for a man as fond of work and power as Mr. Edwin Chadwick) being lost by putting the screw on too tight.

The towns of England *were dirty*, and the theory of the machinery of the Board of Health for introducing local improvements (supposing respectable and competent persons are employed to hold the preliminary inquiries) was infinitely superior to the costly and cumbrous process of an Act of Parliament. So that, with a light hand, the towns might have borne the blame of failure and the Board reaped the credit of success. But the feverish desire to make every one pipe to his own tune which devours Mr. Chadwick,

raised a small rebellion, in the course of which he retired, like other benevolent despots, on the fruits of his previous labours.

Nothing could be more systematic than the manner in which the Board of Health began to work out its peculiar and altogether delusive theories.

These theories were reduced into an authoritative shape, as "Instructions," and fortified by "Reports" and "Extracts from Evidence." One leading canon or maxim pervaded all these publications, viz. that except the chosen band of the Board of Health—the Rammells, Rangers, Rawlinsons, &c., no engineer was competent to execute sewers and water-works, although, curiously enough, several of these gentlemen made their first experiments as Board of Health engineers, and one at least began by copying the water-works plan of an engineer against whom he reported.

Armed with the false evidence in favour of the plausible although absurd theories set forth in official Blue Books widely distributed, the Board of Health took advantage of the terrors excited by the cholera, the popular movement in favour of improved sanitary arrangements, and of the apparent economy that their special powers afforded (as compared with a private Act of Parliament) for enlarging or reforming local powers for local government, to induce a large number of towns to apply to be placed under their rules, and to substitute a "Local Board of Health" for all existing local government.

Thus, when a town made an application to the Board of Health, an inspector was sent down to

make a preliminary inquiry. The inspector was a Board of Health engineer, paid by fees, and open to private practice. He invariably reported in favour of applying the powers of the Board of Health, that is to say, in favour of giving himself a job; described in the most unfavourable terms every public work in the town, and garnished his report with extracts from the pet maxims of Mr. Edwin Chadwick. This report was forthwith printed, and became "an official document," while the inspector was able to make just such statements as he pleased without contradiction, and quote in the next town he visited. If any party in the town reported or opposed the introduction of the despotic powers and peculiar hydraulic theories of the Board of Health, they were at once denounced as "selfish," "unprincipled," ignorant," "lovers of dirt."

After the report, if with or without a poll the town accepted the Board of Health Act, the inspector generally became the engineer; but if the locality had an engineer of their own choice, two courses were followed: in the one the inspector, backed by the influence of the Central Board of Health, made a party in the Local Board to reject the plans and expel the unlucky heretic engineer who did not put faith in the "quart-into-pint theory," and did not estimate sewerage water at the price of guano.

The official inspector canvassed the town in his official capacity, and showed by official reports and the "Trial Works Experiments," what immense savings would be effected in consequence of making

use of the Board of Health instead of the non-official engineers. If that failed, and the locality was so rash as to employ a man who did not believe in Mr. Chadwick's Trial Works, then the screw was put on. The locally-chosen engineer was called upon to submit his plan in minute detail, and, as a matter of course, it was rejected. The Central Board of Health refused leave to raise the money required for the works, and the sewerage and water plans of the locality were brought to a stand-still until either the engineer came in to the Board of Health's plans, or the locality accepted the Board of Health inspector as engineer, who was soon prepared with a plan founded on the information filched from the details he had forced from the original engineer.

The Appendix of a Report of the Board of Health in 1849, contains a circular of instructions to the official inspectors, from which it appears that the Board of Health amateur engineers, on the strength of the "Trial Works Demonstrations," ordered that "impermeable tubular drains," that is to say, glazed pipes, should be exclusively employed as main sewers, —that plans "deficient in detailed application, in respect to the application of the refuse of the town to agricultural production," should be rejected without examination.

With such temptations in the way of a cheap Board of Health inquiry, instead of a costly parliamentary contest for a local bill, with a growing feeling in favour of the execution of works for water supply and sewerage as a question of health, with powers of

corruption and persecution which the Board most unscrupulously exercised, by denying employment to every surveyor or engineer who would not subscribe to the Chadwickian creed, and by supporting official inspectors in first filching the plans, and then monopolising the business of independent engineers,—it is not surprising that the Board of Health managed to do enough business every year to manufacture a pile of Blue Books. Every town that came under their inspection was the subject of a printed report, with plans, maps, and diagrams, and every report was of the same pattern. The printer of the Board of Health must have had a capital berth.

Of course towns which had had no water supply and no sewers were, except at Sandgate, decidedly improved in health by having a water supply, however insufficient, and a set of sewers, even if continually stopped up. But when Mr. Chadwick and Mr. F. O. Ward claim triumphant success, and a vast economy by what they call their “new improved system of pipe sewers,” “new improved combined back drainage,” and “new improved water supply”—we quote the words from the Board of Health circular—we are tempted to turn from the assertions of pensioned and would-be-pensioned agitators, to the evidence of men of character and professional reputation, who do not content themselves with round statements, but give names and dates which every one can test.

Engineers of character, education, and experience do not dispute that earthenware pipes may often be advantageously employed, that “combined back

drainage" is sometimes economical, and that a "constant supply" of "pure soft water" is a most desirable, although not always possible, luxury. But the works of engineers who are not the slaves of a Board, are planned as they are required, on the principle that "circumstances alter cases," with the advantage of their own personal and the general experience of the profession, and not empirically in one official stereotyped mould.

Some account of the failure and liability to "deposit" of the earthenware pipes where improperly applied, of the general excess of estimates, the extravagance of the Board of Health engineers, and of the despotic and unscrupulous manner in which Mr. Chadwick tried to trample down all who opposed him, will be found in reports laid before the House of Commons, and in a letter addressed to the Marquis of Chandos as Chairman of a Committee of the House of Commons, on the Great Grimsby Improvement Bill, by Thomas Hawkesley, C. E. For instance,—

"Sandgate—two-thirds of pipes stopped and relaid, fever and cholera broke out; water supply stopped at night; requires filtering; cost not £850, as stated, but £3800. Exeter—not half-drained; cost, not £2371, but £9000; sewage manure-tank a horrid nuisance. Leamington—Mr. Chadwick suggested that Mr. Hawkesley's services should be dispensed with; at Leicester, he objected to Mr. Wicksteed; at Coventry, where Mr. Hawkesley acted for the Corporation, Mr. Ranger, Inspector of Board of Health, *became* engineer; at Great Grimsby, Mr. Chadwick suggested to Lord Yarborough that Mr. Rendel, late President of the Institute of Civil Engineers, the engineer of Great Grimsby Docks, should be superseded by an inspector; at Croydon, Mr. Ranger objected to and

altered two plans successively submitted to him as the Inspector of the Board of Health, and then became himself the engineer, with a plan which failed. In February, 1853, there were 44 cases in which, in the same way, public inspectors became private engineers.”—[This letter of Mr. Hawkesley’s has never been answered.]

But we will go further, and quote a few details.

As to Croydon, we happen to have a report prepared by order of the Home Secretary, by Thomas Page, Esq., C.E., and Dr. Arnott (so well known for his contributions on ventilation, stoves and fire-places), once a friend of Mr. Chadwick, but since rejected because he would not be “the unscrupulous lawyer’s slave.”

Dr. Arnott, who was on the first and second Metropolitan Commissions of Sewers, after describing the peculiarities of the site and water supply of Croydon, says :—

“The site of Croydon required a system of draining specially accommodated to the peculiarities—that is to say, capable of carrying away an unusually large quantity of water; but, on the contrary, a system exhibiting a strong contrast even to ordinary drains has been there introduced, namely, that of small stone-ware pipes, only large enough to carry away the house sullage and rain-water from the roofs and yards, which sullage being the portion left after evaporation, &c., of the water distributed to the houses from the public waterworks, is in small quantity. These pipes were intended to be impermeable, and to have air and water tight joinings, so that no foul air should escape from them, and no water from the earth around should enter them. To perform the remaining duty of carrying off the waters of the subsoil springs, of pond overflow, and of rain falling on the streets and open spaces, no sufficient general provision was made, and the means tried, as

mentioned below, in two situations have proved inadequate. Such waters, therefore, had to find their way to the river by what remained of the old faulty drains, rendered now more unfit from being cut and interfered with by the new drains, or by overflow.

“Under the circumstances of insufficient channels for drainage here described, two great evils not anticipated by the Board of Health arose. First, the joinings of the small stone-ware pipes, which the theory assumed to be water-tight, were found in practice not to be so, for in various places the water of land-springs, rain, or the Bourne overflow, accumulating around them, found admission, and being added to what was already within, occupied the whole pipe, so as to produce not only serious obstruction to the onward passage of the sullage water, but total obstruction to the passage along the pipes of all foul air from sinks and closets, so that the ventilation of these in the direction of the water current, as intended in the plan, was rendered impossible. Such air, therefore, was necessarily left in or about the houses, adding very hurtfully to the malaria of the town. The second unforeseen evil proceeding from the imperfect joints of the pipes, and the entrance of water from around them, was, that the quantity of mixed sullage and water running along the pipes to the filter-house, where a strainer was placed intended to separate and retain all solid matters, and to allow only the liquid part of the sullage to reach the river, was much greater than the filter could admit, or than could pass by the pipes leading from the filter-house to the outfall lower down the river. The consequence was, that much water loaded with the disgusting part of house sullage, which formerly remained in the cesspools and was carted away at nights, was at first, during the whole day, visibly admitted to the river near the filter-house, and afterwards, when the complaints of such contamination became loud from the inhabitants of the river banks, was admitted to the ditches of adjoining fields, and caused there a nuisance almost equally offensive. With larger sewer channels, or with a separate sufficient provision for carrying away subsoil water, the evils just described would have been altogether avoided.

"But besides the now apparent unsuitableness of small pipes to the peculiar state of Croydon during the last season, the Croydon experience has given evidence of other accidents causing diffusion of hurtful malaria, to which the pipe drains are liable merely because of their fragile nature and smallness. In a book kept at the Town Hall of Croydon, upwards of 50 stoppages of main pipe sewers were recorded during the early months of their existence, while a still larger number of stoppages, not recorded, are known to have happened in the smaller or private house drains, occasioning altogether great annoyance, malarial nuisance, and expense. The causes of the obstructions were very various,—for instance, breakages of pipes from weight of incumbent earth, or from heavy carriages passing on the road over them, subsidence or bending of portions of the drain in yielding ground, arrest of bulky solids, accidentally or maliciously introduced into the narrow channels, fibrous substances like hay, human hair, thread, pieces of cloth, &c., sticking together with other sullage matter, and gradually growing to the condition of complete plugs. Such events occurring in a place like Croydon, near the Central Board in London, for easy conferences, prove that the desirable securities for the efficient performance of such works are not yet possessed, and further show that some of the anticipated advantages of the pipes have not been obtained, and some of the drawbacks connected with the employment of them had not been foreseen. It is true also, that in other localities failures like those at Croydon have occurred, leading in some cases to the removal of the pipes, and the re-adoption of the brick structures. In Leeds and Manchester, the combination of impermeable tubular drains for *single buildings or small areas with larger channels* for main sewers, is said to unite the advantages expected from the tube system with the security against accidents which belongs to the brick channels."

Here, then, is the evidence of a scientific physician, of well-known character, reporting to the Secretary of State.

Mr. Page, the engineer, takes a more professional view of the subject. He states that—

“Mr. Ranger, one of the superintending inspectors of the General Board of Health, was employed by the Board to survey and report upon the state of Croydon, and he describes (12th April, 1849) the condition of the place with reference to want of sewerage, land drainage, water supply, and sanitary arrangements.

“Mr. Donaldson, one of the engineers of the Metropolitan Commission of Sewers, prepared a plan described in a Report, November 27, 1849. This Report was forwarded, Feb., 1850, to the Board of Health, ‘who required that previous to their sanction being given to the plan, an engineer appointed by them should report whether the contemplated works were expedient, and whether the estimate was correct.’ Mr. Ranger, who had reported as inspector, was appointed for this purpose, and he, after altering the plan and specially reducing the size of the pipes from 6 inches to 4 inches, and from 8 and 9 inches to 6 inches, so on through all the sizes, reported in its favour to the General Board, who gave their sanction to the plan, *stipulating, however, that ‘no expense should be incurred without the approval of their superintending engineer, whose certificate should be necessary previous to any outlay.’* ‘The General Board also required an enlarged plan of the town to be made.’ Mr. Ranger, official inspector and superintending engineer (Mr. Donaldson retiring), became the engineer to the Local Board.”

Mr. Cuthbert Johnson (a Commissioner of the first Metropolitan Sewers Commission, and a personal friend and pupil of Mr. Edwin Chadwick) was Chairman of the Local Board.

We would ask, if these measures of precaution did not fix responsibility on the general Board of Health, and if these officials did not secure a model plan ac-

ording to the ideas of Mr. Chadwick, who and what would?

Mr. Page and Dr. Arnott held two public sittings at the Town Hall, and eighteen respectable witnesses, whose names are given in the report, gave evidence on "stoppages and sewers, and house-drains and consequent accumulation of filth and its overflow into houses and yards, the horrible stench, escape of noxious effluvia into the houses from the water-closets, sinks, &c. The exposure of sullage pumped into the street, the nuisance caused by searching for stoppages, the smells from the filter-house, the pollution of the Wandle, and bad odour from the water."

Certainly a formidable catalogue of calamities arising from "a new improved model system," created by a Board of Health officer "of special qualifications," under the direct superintendence of a "Board composed of gentlemen especially selected for the attention they had paid to sanitary subjects." We quote where we can the terms in which, to use the words of old George Selwyn, the Board of Health Reports "praise themselves and bullyrag their opponents."

Mr. Austen and Mr. Grainger, two Officials of the Board of Health, excuse these failures by imputations on the tradesmen who executed the work, and on everybody and everything except their system. Allowing them a large margin for such mischances, where—if not at Croydon, a town so well placed and carefully nursed—is a perfect system to be found?

Combined Back Drainage is a system much lauded

by Mr. F. O. Ward and the Chadwick School; here is the description of Mr. Page's report:—

“ One of the causes of the numerous stoppages, and a source of annoyance to the inhabitants, was the system of forming the sewers at the *back of the houses*, called back drainage, by which the soil from several houses is passed into the same branch drain, a stoppage in which affects all the houses above the point of the obstruction.

“ Whatever advantages there may be in avoiding interruptions in the public streets, caused by breaking them up for examinations of pipes, *or to remedy the now rare occurrence of faulty execution in brick sewers*, it is certain that for one family to be subjected to annoyance by the neglect of another—to the overflow of sullage—the escape of poisonous gas—the suspension of the usual means of cleanliness—to the entry of the workmen into the house, garden, or yard, to search for stoppages or make repairs, must far more than counterbalance such advantages, and that any saving in the length of the house-drains, or in obtaining a more rapid inclination, is effected at an infliction on the householder, which cannot be estimated by pounds, shillings, and pence. The system is also especially calculated to produce dissension among neighbours, whose indignation is excited by the reflow of filth into their houses (notwithstanding it be, as has been observed, not more than three inches deep); the unfortunate owner of the stopped drain, when the fault is discovered, is loaded with their reproaches, and he again unites with them in execrating the Local Board of Health, and especially the surveyor, *while the author or promoter of the mischievous system, which works so admirably upon paper, is sitting in self-gratulation far away from the scene of strife.*

“ Practically speaking, if each house have a direct communication with the main sewer, and that main sewer be large enough to carry away all the matter discharged into it, and be well ventilated, no nuisance can occur but from imperfections in the house-drains themselves and the domestic appurtenances attached to them. And for the house-drains, the pipes are ex-

cellent, when the joints can be made and maintained perfect. But this system is the very reverse of the back-drainage."

So much for Croydon, often impudently quoted as an example of the "new improved system." The whole report, which is very calm and impartial in tone, is well worth reading.* But Croydon is only ten miles from London. Any one inquiring will find that up to this hour the stoppages and repairs of the street sewers are of daily occurrence; the sewage-ometer is a complete failure.

Turning from Croydon to London, we find from Mr. Bazalgette's Report to the Commissioners, dated February, 1853, that between October, 1851, and December, 1852, 22 cases of cleansing and repairs had been required. Examinations made in 11 places indiscriminately, at depths of from 8 to 17 feet, showed 5 cases of broken pipe, and 6 cases sound. Out of 122 examinations, 9 were found entirely choked, 47 contained deposit less than $2\frac{1}{2}$ inches in depth, and 66 from $2\frac{1}{2}$ inches to 7 inches in depth; besides these cases, in a list of stoppages and breakages, 200 were remedied by removing the obstruction by flushing, or rods; in 16 the pipes were taken up and cleaned, and in 30 instances the broken pipes were taken up and larger pipes substituted. Among those at St. Olave's and St. John's Workhouse, the 4-inch and 6-inch pipes were found full several times. Pipes in Rose Street, Soho, were taken up and cleansed, and

* Reports by Neil Arnott, M.D., and Thomas Page, C.E., on an Inquiry ordered by the Secretary of State relative to the Prevalence of Disease at Croydon. Presented to both Houses of Parliament, 1853.

re-laid five times between August and December. On Mr. Duncan's property at Kilburn, about 1000 feet of 15-inch pipe, broken, were taken up and re-laid. In Parker Street, Drury Lane, a 9-inch pipe sewer was abandoned, the pipes being full of deposit, and a brick sewer was built. At George Row, Dockhead, pipes failed, and were abandoned, after having cost £408—new pipes were substituted at a cost of £985. In the rear of Chatham Place and Rodney Street, the pipes were found insufficient to carry off the water; the neighbourhood was flooded, and, consequently, a brick sewer was built. At Peckham Rye, an 18-inch pipe sewer stopped within twelve months of completion, and new pipes, which cost £77, were substituted.

Sandgate, a pretty sea-coast village, having been decimated by cholera *after* the execution of the model system of drainage, Sir Benjamin Hall, the President of the General Board of Health, ordered an inquiry by Mr. Thomas Blackwell, C.E.

Sandgate, containing only 302 houses and 1400 permanent inhabitants, exclusive of sea-bathing visitors, extends $1\frac{1}{4}$ mile along a shingly beach.

A combined drainage and water supply system was executed by Mr. Rammell, an "Official Inspector" of the Board of Health, in 1852, with 4-inch pipes for house drainage, 6-inch, 9-inch, and 12-inch for main drainage. Previous to Mr. Blackwell's inquiries, out of about 2000 yards of public sewers, 700 had been taken up and relaid in consequence of stoppages and failures. Nevertheless when Mr. Blackwell went down and had nineteen openings made, he found a large

amount of deposit, complete choking up and other serious failures in seven instances, in several amounting to many yards. Yet these were, according to Board of Health theory, "self-cleansing sewers." Mr. Blackwell also reports a failure in the quality and quantity of the "water," also supplied on the new improved system.

We do not believe that the attack of cholera at Sandgate was entirely due to defective drainage, but we cite it as instance No. 2 of cases where sewers constructed on Board of Health principles by a Board of Health Inspector failed, and became "sewers of deposit," "elongated cesspools."

Rugby is another town cited as an instance of a great success, and figures in the "General Report" of January, 1854, as sewered for £3600. In the same year Mr. Bazalgette made an inquiry. He found the cost of the public sewers £5000, without the cost of the town survey, £814. To this must be added the cost of destroying cesspools and laying on private works to replace them, which, at £8 a house, would amount to £8800; according to inquiry, the cost varied from £5 to £550. "The cost of earthwork for laying sewers and all incidental expenses, including pavement, has been 10*d.* per foot lineal, for sewers 10 feet deep, *a sum which would not cover the cost of merely repairing street pavement over such a work in London.*" The water supply of Rugby cost £10,000; but has since been found insufficient, and a further expense has been incurred. The works were planned by Mr. Rammell, an official inspector. At the time of the

report, only two-thirds of the houses drained into the sewers. In the *Northampton Herald* of the 18th of August, 1855, at a meeting of the Rugby Board of Health, the clerk was instructed to inform Mr. Rammell that the town was dissatisfied with the present outlay, and the failure of the water so soon after the setting in of fine weather last year. At a subsequent meeting (*vide Northampton Herald* of Sept. 1st, 1855), a member of the Board stated that he "had no faith in the present system of water supply," and that "from past experience the Board is not justified in spending more money on the present system." Much has been said about the application of the liquid sewage of this town on the adjoining lands, but the above paper states that the Board at that meeting received "one month's notice of action from C. M. Caldecott, Esq., for pollution of the river Avon;" the damage was laid at £500. Rugby is the model instance of sewage rented at £50 a-year to be applied to 450 acres of land, chiefly grass, by a friend of Mr. Mechi, with jet and hose.

Travelling south-west we reach Lord Ebrington's favourite example of his friend's "new improved system," St. Thomas's, Exeter. Here we expect, from the noble lord's confident harangues, a perfect system in full work—a model of sanitary, social, and engineering arrangements. But what do we find? Only one water-closet for two or three houses; one block of twenty-one houses with only seven water-closets among them. The following is the official plan of manufacturing a cheap water-closet. Behind a row of poor

cottages or in a court, an old privy or pig-sty is acquired; a 4 or 6 inch drain-pipe is led to the main sewer, if it did not before exist; a syphon pan is set up, and a water tap is brought over it; half-a-dozen open privies are filled up; the work is done!—and the expense is divided among a sufficient number of houses to bring it down to the Board of Health figure, $1\frac{1}{2}d.$ per house per week. But ratepayers will deceive themselves very much if they calculate that this will be the end of the parish expenses. To keep such a closet in a decent working state, a scavenger must and does attend at many score houses in the city of London once or twice a week at least, at an expense of from 1s. to 2s. 6d. a-week; if not, the affair will become a greater nuisance than any open privy. As a makeshift, we understand it; but as a model improvement, it is something worse than the old privies that were closed. There is nothing more degrading or demoralising than such a system. The contractors and clerks of the Local Board of Health of St. Thomas's, patronised by Lord Ebrington, refuse all information and account of their expenses. But it seems that, while quoted as a district drained and sewered for £2371, it is really not half drained, and that when the essential expenses of a complete system are added, including cost of surveys, supervision, &c., and a water-closet to every house, as recommended in Board of Health reports, the cost would amount to £9000.

These are the tricks of the Chadwick, Ebrington, and Ward school, like the puffing drapers, who put

a small figure inside a large one. Their complete suit consists of a pair of ill-fitting breeches, without coat or waistcoat.

Cardiff, in 1850, much needing a system of drains and water supply, placed itself under the powers of the General Board of Health, and applied to the Board for a plan. In December, 1851, Mr. Rammell, official inspector, supplied a plan—the old pattern—small pipes, no provision for flushing sewers; rainfall and other surface water to escape by the old sewers, or along the surface of the street, until it reached the port. The Cardiff Local Board included some men of business, not without experience in mining operations; so they doubted, and proposed to take the opinion of some engineer of eminence on this—the stereotyped Board of Health plan. A deputation was appointed to visit various towns, and report the result of sewerage experience. They published the result of their tour in a pamphlet, from which we gather the following items of information.

In London they saw Mr. Rammell, who referred them to Mr. Grant, surveyor of the Kennington District. Now Grant was the show surveyor, in charge of a certain set of pipes, which were always shown to deputations in search of the best system of sewerage. Mr. Grant told them that he had used 40 miles of pipes for drains, and that no case of stoppage to any extent had ever occurred; that pipes would act with the common domestic supply of water, if ordinary care were taken.

Mr. Rammell had recommended a steam-engine to

pump up the Cardiff sewage, in a manner that rather startled the Cardiff Board ; for a steam-engine, wherever possible, was one of the fixed ideas of the late Board of Health school, and these too are all of the same pattern. So the deputation asked if Mr. Grant "could point out any place where an engine could be seen working in the manner proposed for Cardiff?" He answered, "that he could not, but that they were about to erect two of 500 horse-power each, for a similar purpose."

And if they had asked where liquid sewage was to be seen producing great corn crops, he would have answered them in the positive future tense,—

"Man (the Board of Health man) never is, but always to be blest."

"Mr. Grant took us," the deputation relate, "to various places in the neighbourhood, where we saw the earth removed, and pipes exposed. Some of the pipes were disconnected, to enable us to see their action, *and we perceived water in a nearly clear state flowing freely through them. On reflecting that such could not be the usual condition of a drain, we examined the gardens of the adjacent houses, and found that the water was let on.*

"We were then taken to a place in the same locality, where a brick sewer was exposed in a stagnant state, with no appearance of water having been admitted. There was a deposit of stagnant sewage matter to the depth of 11 inches, but there appeared sufficient area left for drainage."

This Mr. Grant is the same gentleman who is

quoted by Mr. F. O. Ward, to prove that pipe sewers examined and reported as full of deposit in 1853 (in the Report laid before the House of Commons) were quite clean in the following year. This seemed odd to those who were not up to the unscrupulous tricks of the quart-into-pint school, but it is explained when we find that,—

“ A month after my (Mr. Bazalgette’s) examination, I learned that Mr. Grant had constructed three flushing-shafts in the line of this sewer, and that his examination was made just below one of these shafts ; and he has stated at the foot of his diagram that these pipes could, at any time, be instantaneously flushed out throughout their whole length ; but I was surprised upon accidentally discovering that, within four months after his examination and statement, a considerable length of this very sewer, only 50 feet above the point examined by Mr. Grant, had been taken up and relaid, having been stopped up with deposit, and the houses flooded in consequence. Upon calling in Hamblin, the clerk of the works, who had superintended the job, I learned that, in addition to this, the sewer in Upper Fore Street, Lambeth, which appears in the 4th diagram of Mr. Grant’s examination as a clean sewer, as opposed to my representation that it contained five inches of deposit in 1853, had also been taken up and reconstructed three months after Mr. Grant’s examination, and that it was found full of stagnant water with some deposit. I also learned from the same clerk of works, that portions of the adjoining sewer, in Gloucester Street, had been taken up and reconstructed.”

We do not know anything of Mr. Grant except this—his district was the show district ; but after these two incidents, we cannot help thinking of that Lord Aldborough, so long the standing dish of an advertising quack. And we agree with the Cardiff inquirers, when they say, “ *We were impressed with*

the conviction that our inspection was not of a casual or accidental character, but that arrangements had been made beforehand for our coming !”

“ Mr. Roe exhibited a plan of sixty houses, in which fifteen were marked as inconvenienced by stop-pages. *He condemned pipes for sewers, inasmuch as the gritty substance washed from the road surfaces formed a compact concrete, which required an iron tool to remove it. This deposit commences in six months, and ultimately chokes the pipes.*

“ Mr. Donaldson said as to Richmond, a small town on a hill, that he was directed to drain it by the pipe system ; that *he found pipe-sewers liable to choke, unless there was a quick fall and constant supply of water running through them.*”

He has known the pipes used as gulleys into brick sewers at Westminster (laid down by Mr. Chadwick’s first or second Commission) broken up two or three times after a heavy storm, by being choked up by road-drift.

Another engineer wrote to the deputation, as to the drainage of Carrier Street, which is often quoted by Mr. Chadwick and Mr. Ward, as a model of cheap “combined drainage.”

“ Every means has been taken to ensure perfect action. The supply of water is constant from a tank 25 feet high ; the gradients of the pipes from one in fifty to one in sixty ; the work was well constructed ; nearly all the houses have water-closets on the automaton principle, self-acting, and cause a discharge of water into the pipes, every five or six

minutes, both night and day ; nevertheless fifteen stoppages have taken place in the last five months."

These instances of extravagance and failure are only a few out of many. We might describe Hitchin, where the expenses of the Ordnance survey are unpaid, and never likely to be paid : the river is poisoned by the model system. Ely, with its muddy water supply. Salisbury, where, according to the *Wiltshire County Mirror*, 28th of February, 1855, the unfortunate Mr. Rammell was subjected to a severe badgering by the Local Board. His boasted economical estimates had been exceeded by some 25 per cent. It seems that "on the 28th of December, 1854, Mr. Rammell addressed a letter to the Board, in which he congratulated the Board that the works were completed, and that the expense was under £24,000." This boast went the round of the Board of Health organs, and figured in the 1854 Report ; but it turned out an extra £4000 would not pay for work yet to be done. Mr. Alderman Smith was very fierce ; he said, "Mr. Rammell said nothing in his first Report about flushing wells ; but if they were necessary now, they were required at the commencement of the undertaking. They had been led on step by step ; in fact, they had been deceived from beginning to end." (Cheers.)

At Folkestone we find a total failure of the works. At Dover, another one of the boasts of the old Board of Health, the plans changed and changed again ; the estimates largely exceeded ; the works suspended ; the Local Board at law with the engineer and con-

tractors ; vain appeals to the present Board of Health—confusion worse confounded.

But one of the most flagrant and latest instances of the effect of the interference of the Central Board is to be found at Southampton, which was quoted by Mr. Chadwick as a model of his economical plans, where Mr. Ranger, a very favourite engineer of the Board of Health, employed as inspector, of course superseded the engineer previously employed. After working in his own way for five years, the works are unfinished ; the Town Marsh, a valuable portion of the town near the railway station, let on building leases by the Corporation (including Radley's Hotel), is under water whenever a storm of rain occurs, there being no provision for the rain-water in Mr. Ranger's plans. The two 20 horse-power pumping steam-engines designed by him are found unequal to their work ; and he now proposes a pumping establishment of 230 horse-power, equal to that of a London water company. The great tank or sewageometer has been abandoned, as it would certainly have burst the first time it was emptied ; the farmers do not show the least intention of paying any part of the rent of £5000 a-year promised by Mr. Ranger as the prize to Southampton for adopting the Chadwickian novel system of sanitary works ; deposit is constantly obstructing the sewers ; the outfall, not having been settled, remains a subject of discussion ; the estimates have been exceeded by £20,000 ; and the town is worse off than when the Board of Health took it under its care.

The following extracts from Mr. Ranger's Report in 1851, and from Minutes of a Report of his Interview, 1855, with Mr. J. Simpson, late President of the Institute of Civil Engineers, to whom the half-drowned Southamptonians applied in their distress for advice, are very instructive. The first report is a complete model of the Board of Health documents.

"GENTLEMEN,—The general principles which ought, in my opinion, to be adhered to, in laying out a well-arranged system of sewerage and house drainage, so that the defects which now so generally prevail may be avoided, may be classed under three distinct heads.

"1st. With respect to material.

To employ pipes for both the sewers and house drains, made of non-porous materials, which will not absorb or retain anything offensive from the fœtid liquid passing through the pipes, or permit the infiltration of water from the surrounding soil.

"2nd. With respect to size.

"To employ pipes large enough for the performance of the full duty required from them, but no larger, so that the interior evaporating surface of the sewage, as well as the space for the retention, evolution, and diffusion of gases may be reduced to the smallest possible limits.

"To effect this, the storm waters of the catchment (*i. e.* 700 acres) must not flow into the pipes, but be carried off by the existing sewers and such other conduits as at present form the channels for their discharge.

"3rd. With respect to their ventilation and the discharge of their contents.

"To make the flow through both sewers and house drains as rapid as possible, and above all to guard against the chances of obstruction or deposit within the pipes, by using the greatest care and precaution in their manufacture, their form, their slope, and their junctions with other pipes."

"The area upon which the town stands is peculiarly situated, being divided by nature into two distinct districts of

drainage or water sheds of unequal extent, the summit of the dividing ridge or line separating the two, lying a little to the eastward of the High Street; from this summit the ground falls very rapidly towards the river Lest, constituting the smaller or western district, while, in the eastern district, or towards the marsh land in the vicinity of the river Itchen, the inclinations are of a more moderate and gentle character.

"In order that the sewage from these two districts may be prevented from finding its way into the river, as at present, it will be necessary to construct intercepting sewers for each district, which may lead towards Blechynden and Northam respectively, or they may lead from Blechynden, Northam, and the upper portions of the eastern district to the southern extremity of the town, and concentrate in the vicinity of the railway terminus; the sewage in either case to be lifted by steam power; but as by the latter arrangement the entire drainage will be concentrated at one point, and but one pumping establishment required, I beg to recommend it for your adoption, in preference to the former one.

"The sewers are to deliver into an (iron) air-tight cylinder, in conjunction with the suction pipe, from whence the sewage matter is to be pumped into distributing pipes, every passage from the sewers or cylinder to be connected with the furnace of the engine, by which means the offensive gases evolved, if any, will be consumed, and annoyance prevented."

"In my opinion, a complete system, on the principles I have already set forth, will require a length of at least 40,000 yards of sewers, which may be laid down according to my estimate for the sum of £26,000, inclusive of the outlay for the pumping machinery, conducting pipes, and the other works requisite for the application of the sewage to agricultural purposes."

"All persons are agreed upon the necessity of abandoning the old system, by which the contents of the sewers were discharged upon the shores of the nearest river or watercourse, and allowed to run to waste."

"Taking with it the universally-admitted truth that town manure is better than any other (?), it follows as a matter of

course that by the application of the sewage of Southampton in a liquid form, the farmer in its neighbourhood will not only have the command of an additional supply of manure, but he will also be able to obtain and use it in a more valuable form than he has yet had the means of doing."

"Presuming that there will be no difficulty in finding a market of sufficient extent to consume the sewage of the town, I have made the following calculations respecting its probable quantity and money value."

"Total amount expended on Mr. Roe's plan			
up to 1849	£26,864	7	4
My estimate of the cost of the sewers and			
the machinery for the application of their			
contents	26,000	0	0
	<hr/>		
	£52,864	0	0

"Annual Expenses.

"Interest, coals, &c.; Depreciation, engine-			
man's wages			
	4,201	3	6
"Now, the quantity of sewage from 6320			
houses, at 40 gallons per house per diem,			
= 412,000 tons per annum, and if sold			
for 3 <i>d.</i> per ton, would bring in a revenue			
of	£5,150	0	0

"It will be seen from the above, that if the proposed application of the sewage to the lands in the vicinity of the town be carried out, the ratepayers will be relieved not only from the charge already incurred for the construction of the existing sewers, but also from an annual burden in the form of special district rates, to defray the expense of laying down the system of sewage now under contemplation."

"My estimate is derived from the experience I have acquired in my inspection of districts, very similar in the nature and character of the soils to that of Southampton."

When the works were proved to have failed by the floods of September, 1855, Mr. Simpson was called

in, and the following is a Memorandum of his interview with Mr. Ranger, 24th January, 1855 :—

“ In reply to Mr. Simpson’s inquiry respecting the proposition of carrying off storm waters by ‘ existing sewers and other channels,’ Mr. Ranger stated he should have found these, and applied them during the progress of the works, with, perhaps, new sewers to a small extent, for conveying the rain water separately to the river, or Southampton water; but he would not admit that a separate system of drains was necessary for the purpose, or that it required two series of sewers, one for sewage and one for storm waters. He also stated that he intended, in particular cases, to let the rain water into the sewers connected with the pump well.

“ Mr. Ranger observed the plans did not show any second set of sewers, or all the details he intended to apply. He proposed to provide for the storm waters as the works progressed.

“ Mr. Ranger said, in reply to a question of Mr. Simpson’s, as to the connection of the existing with the new sewers, and the consequent conveyance of sewage and storm waters mixed together, that he had given no instructions to his assistant (Mr. Morgan) to make such connections, and he believed they had not been connected to any great extent, and that on this subject Mr. Morgan must have misinformed Mr. Simpson.

“ Mr. Simpson then inquired the object of the large sewer post, the gaol, and round the western shore, if not to take the Blechynden and Bedford Place drainages? Mr. Ranger said it was for sewage only, and that the storm waters were to flow away into the sea by the surface channels. Mr. Simpson then inquired how such a state of things could be applied to High Street, for instance; to which Mr. Ranger replied, that special means must be taken to provide for such cases.

“ Mr. Simpson observed, the flow of water down the channels of High Street and some of the lateral places was large in rainy weather, and that many of the gratings and gully-holes in Southampton were double the size of those in the majority of towns in England, and if the rain water was to be

passed off by means of the street channels, they would be at times like little rivers, and be liable to injure the house and shop property, and this must sooner or later necessitate separate sewers or drains for the storm waters.

“ Mr. Simpson said he concluded from the description of the proposed works in the Report, October 16, 1851, that the whole of the sewage was to be lifted by steam power, and the entire drainage concentrated at one point with one pumping establishment, and that this plan was recommended for adoption in preference to the plan of suggested outfalls ‘at Blechyn-den and at Northam respectively.’ Mr. Simpson expressed a doubt of the practicability of carrying out the plan with one outfall. Mr. Ranger said that such was the intention, and that he had not hesitated to proceed to carry it out, and that as much of the storm water as possible was to be carried off as before stated.

“ Mr. Simpson asked why the sewers at the outfall had been constructed lower than the levels stated in the Report ?

“ Mr. Ranger said he believed his assistant, Mr. Hazard, had done this to obtain the required gradients.

“ As to the termination of the Northam branch of the sewer, at 60 feet above ordnance datum, Mr. Simpson inquired, why let the sewage down from such an elevation, and from the greater height of Bedford Place, &c., to be pumped at a constant expense ? Why not convey it to the river or Southampton water, at levels above high water, and let it fall into a covered tank and pass away through a low pipe into the stream, at the level of low water ?

“ Mr. Ranger said the General Board of Health were of opinion one outfall was most advisable, and it was considered it would be the least expensive mode, and he acted and advised under their approval.

“ Mr. Ranger said some of the members of the late General Board of Health were of opinion that sewage manure could be sold to the farmers at a profit, and that experiments were now being tried at Leicester, Rugby, and other places.

“ Mr. Simpson replied, that at Mansfield, where there was no pumping, he understood it had not paid 3 per cent. on the outlay ; and the Fulham Fields experiment was a total failure,

after an expenditure of upwards of £40,000, the sewage in that case being so water-washed and inferior, that latterly the market gardeners preferred Thames water.

“ Mr. Simpson inquired, why not confine the sewage to be pumped to the smallest possible limits, even if it involved two sets of sewers in some cases? and he observed, ‘ It is not at all obvious even now, that the proposition of one outfall can be brought to bear.’ The discharge of sewage into the Itchen may be at the same place, but the sewers will have to be worked under different circumstances; and further, it was not at all obvious to him that rainfall can be entirely excluded from the sewers at Southampton, and if excluded at the onset, it will be liable to be connected from year to year by every working bricklayer in the town.

“ Mr. Ranger observed, he acted under the General Board of Health, who would only hear of one outfall for the sewers, and they were desirous of seeing sewage manure applied to agricultural purposes; and he added, ‘ You, Mr. Simpson, now are not fettered, and you can recommend what you think best as to having more than one outfall, limitation of pumping, and alterations of the lines and arrangements of the sewers.’

“ Mr. Simpson inquired if Mr. Ranger had ever seen or heard of the sewage agitator, sewageometer, and the other works proposed for the outfall being applied; and he stated that he had not, and he believed them to be novel applications.

“ Mr. Ranger admitted, in answer to Mr. Simpson’s inquiry, that the sewageometer, or store tank for sewage, would be best constructed under ground, without reference to the disposal of the sewage for manure, which could be pumped out and conveyed away at any future time, when it might be considered worth while.”

The end is, that the Local Board of Health at Southampton finds itself besieged, as it were, by the sewage. It will take between £30,000 and £40,000 to clear the city of rain and sewage, and finish the works on a practicable plan.

We conclude here our list of the failures of Mr.

Chadwick's "New System," which might be extended to every district named in the Board of Health Reports, and leave those interested in the subject to visit and investigate personally the nearest town in which the model centralised system of engineering has been applied, and ascertain for themselves what sort of performances have resulted from promises made and reiterated loudly and boldly for more than ten years.

In 1854, the House of Commons extinguished the Board of Health, or rather refused it a new lease of existence. As a compromise, Mr. Edwin Chadwick and Dr. Southwood Smith were pensioned at £1000 and £300 a year respectively. The new Act created a Board of Health for a year, with one paid Commissioner only, the president, who was to be a Member of the House of Parliament, and a staff of secretaries, engineers, medical officers, &c., costing above £18,000 a-year. But the inspecting engineers were to be paid by fixed fees, and no longer permitted to become the private engineers of the towns on which they report. The result of this restriction, combined with the failures of the old Board in carrying its "New System," has been to reduce the present Board, as regards new works, to a sinecure. Indeed, we happen to know that last year the officers of the Board held a private meeting to consider what they should do to give an appearance of importance to their sinecures in case the House of Commons should make inconvenient inquiries before renewing their term of existence for another year.

In the meantime they are tormented by business of

a most unpleasant and unprofitable kind—the complaints of the victims of the empirical despotism of the First Board—they are overwhelmed with correspondence from the Local Boards of Health of Dover, Southampton, Folkestone, &c., all saying, “What are we to do?—we accepted your man, the Board of Health engineer, we accepted the alterations the Board enforced in our plans, we have submitted to the ‘New System of Sewerage and Water Supply,’ our town, our plans, our estimates have formed the subject of self-laudatory illustrations in the Board of Health Reports, and now the works have failed, the estimates have burst their figured bounds. The model engineer, ‘with special qualifications for the execution of sanitary works,’ has left us in the lurch—torments and terrifies the New Board.” The secretary and engineer are wanted to reply, and can only reply by repudiating the deeds of their legitimate parents, the Board of Chadwick. The Local Boards are not satisfied with the ingenious letters that cost so many thousands a-year; and they come in deputations, they besiege Gwydyr House; and then, while the officers—for the president is merely a cypher—are deliberating in an inner chamber on the awful question of “What shall we do to show that we have something to do, and that a Board of Health is earning its eighteen thousand a-year—in an ante-chamber, a bland subordinate explains to the angry deputation that “The heavy, pressing, and immense duties of the Commissioners debar them from fixing a day or hour for an interview.”

- And that is the end of Mr. Chadwick's great Central System of Sanitary Reform. The Board lives now in the hopes of bits of works imposed by little Acts of Parliament, which are from time to time slyly smuggled through Parliament. Like the Yorkshire boy, they ask for salt, then for bread, and hope in the end to get the egg—the golden egg, in the shape of a Permanent Board, with its hands in the pockets of every ratepayer in England.

Centralisation is a power invaluable, where rightly applied. A good coachman effectually centralises the power of four horses—a clever mountebank drives round a town sixteen-in-hand, and thus drives the crowd to his circus—a presumptuous Phaeton rattles his four-in-hand triumphantly along a straight smooth road, while his flunkey plays the cornopean; but a crowd of carts, a sharp turn, or a jibbing horse, lands him, not always safely, in a ditch.

Mr. Chadwick's Board of Health attempted to drive sixteen-in-hand without knowing how to drive at all; and, therefore, distributed its passengers among water, mud, and manure. His successors are more modest; they will be content to do their spirit-ing gently; to interfere as little as is consistent with making a show of work in annual Blue Books to justify their salaries.

To show, however, how much easier it is to make a report than to get a quart into a pint, we give, in Chap. XI., the last published effort of the great charlatan of Centralisation.

CHAPTER VIII.

THE VALUE OF SEWAGE MANURE EXAMINED.

THE idea that sewage manure applied on a large scale could be made an important source of income, and a set-off against the expenses of sanitary works, originated with the late Mr. Smith, of Deanston, a man of a most ingenious and inventive turn of mind, the author of many valuable suggestions, but singularly unsuccessful in completing and deriving any satisfactory result from his great but discursive and unpractical talents. For instance, he was the modern author of that most valuable improvement, subsoil draining; he popularised the idea; but he missed the great discovery—deep-draining; he left that for Josiah Parkes, and therefore when Smith went to work, although he wrote admirably about the advantage of draining, the land he drained (at Drayton Manor, for instance, for the late Sir Robert Peel) had all to be drained over again by Parkes.

When Mr. Smith visited Edinburgh as a Health Commissioner, about the year 1844 or 1845, he found a very successful system of sewage irrigation had been in operation for years. Sewers falling from the hills on which part of the city stands, are only made

to flow over the meadows before falling into the sea. The downfall of the sewerage turned a water-wheel, which pumped a certain part of the sewage at the least possible cost to higher levels. It is the best instance of the economical use of town sewerage in Europe.* And whenever a town, standing on a hill with meadows below, is prepared to put up with such a pestilential nuisance as the Edinburgh sewage water meadows create, there is a handsome rent to be earned from the land, provided the machinery of distribution is not too expensive.

While elated with the discovery of a new source of wealth for sanitary objects, Smith of Deanston, more candid and observant of possible difficulties than Mr. Chadwick and Mr. F. O. Ward, observed, "In making the application of the whole sewer water of a town, so great a proportionate annual income could

* A member of the Society of Arts has favoured us with a copy of the following letter from Mr. W. Haywood, the able engineer of the City Sewers Commission :—

"The following is an extract from my notes :—' 12th August, 1854. Visited the meadows irrigated with sewage water. The area is about 200 acres ; five and sometimes six crops of grass per annum. Meadows are so placed that the sewage, which runs in a ditch right through the meadows, turns a wheel, which works a pump and forces up the water to the highest ground (30 feet above the level of sewer). Two irrigations given to each crop, distributed on upper meadows by hose, on lower by flooding ; hose runs about one gallon per second, applied for ten hours at that rate on half an acre. The superintendent considers the water might be much more diluted than it now is. It is now thinner than formerly. When thicker it made the grass muddy, and it smelt, and the grass did not grow so well as it since has. The ground could not be more favourably situated for the application ; it is immediately outside the town, near Restalrig, on the road to Portobello. The sewage in the ditch smelt strongly. The superintendent said the water ran off quite clear, and tasted like soft water,' &c."

not be obtained as has resulted from the application of small portions, as *the difficulty and expense of conveying it to a distance would require a greater expenditure of money in the machinery necessary to accomplish that object, whilst the value of the produce grown by the application would be diminished by its greater distance from the locality of consumption. A demand for grass grown by the application of sewer water in irrigation has a limit, which would compel the application of the greater portion to the enrichment of tillage lands, the results of which have not hitherto been found so profitable as those from grass lands. Water cannot well be distributed over open tillage lands by irrigation; it would, therefore, be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the sewage water in pipes under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the farm where it is to be used.*" And then he proceeds to describe experiments he has made at the Southwark Water-Works with hose and jet, and to enter into calculations of the cost and profit of subterranean pipe farming (calculations which experience has proved to be ludicrously wrong), assuming that 5 cwt. of sewer water is equal to $2\frac{1}{2}$ cwt. of guano—that the sewer water of every town was worth £1 per head per annum (that would give three millions sterling for London), and that therefore "such an income annually would provide a fund for the improvement of all towns in a manner corresponding with the most enlightened views with respect to sanitary regulations

and improvements of the present time. Obstacles will be found in the way, but *none more formidable than those opposed to the introduction of gas for lighting towns.* With such command of funds as the application of the sewer water will afford, the structural improvement of towns will proceed with steady progress."

Now in the year 1843-4 these assumptions and speculations of Smith of Deanston were plausible and rational; the practice of agricultural chemistry was almost unknown, and he had no experience to guide him; but in the years that have since elapsed, the progress of agricultural chemistry has completely cut away all the elements of his calculations of profit, and proved the value of strong concentrated, and the worthlessness of weak diffused, manures. Nevertheless we find the Board of Health, in their report in 1854, making statements as to the merits of liquid sewage which are not only unsupported but contradicted by all agricultural experience, and Mr. F. O. Ward reproducing Smith's calculations and expectations, *and even his gas-pipe comparison clothed in fine language.*

Analysis has proved that the most potent element of fertility for corn crops is ammonia—that the ammonia in the contents of a closet-pan before dilution does not much exceed one per cent., a percentage which must be considerably diminished by the time the soil has reached the mouth of the sewer. Peruvian guano contains 17 per cent. of ammonia!

Since Smith of Deanston wrote, the manufacture of artificial manures has become an important trade

in addition to the importation of guano.* Superphosphates of lime are made for roots; special highly concentrated ammoniacal manures, for wheat, barley, &c. Night-soil forms no part of these concentrated manures. The first result of the discovery of the value of guano was a crop of cheap and weak manure manufacturers; but experience has proved that a weak manure was dear at any price; and the cheap manures are disappearing from the market. First-rate farmers buy nothing in addition to well-made farm-yard dung and sheep, which, as before observed, are live portable manure distributors, except guano, superphosphate, nitrate of soda, and a few well-established concentrated artificial manures.

The Royal Agricultural Society, in 1852, offered a prize of £1000 for a manure equal in strength to Peruvian guano, to be sold at not more than £5 per ton. The offer was laughed at by manufacturing chemists at the time, because, they said, bring us

* Guano was first experimentally imported from Peru in 1835, but the practical application of agricultural chemistry in this country only dates from the publication of Baron Liebig's work in 1840. That led to experiments on a large scale, and by experiment and experience brought into use the manures suited to grow heavy crops of wheat, with *stiff straw*, and of turnips pushed on so rapidly that the fly could no longer destroy the crop. When guano came into common use, the only two manures purchased were night-soil and bones. Bones are more in demand than ever, but night-soil is left for cabbage-growers. At Newcastle-on-Tyne, Messrs. Ramsay have enlarged their bone-crushing establishment into a great artificial manure manufactory, and sell, in addition to bones, many thousand pounds worth of wheat and turnip manures. The same change has taken place in every agricultural district of England, more or less; and the total sales of artificial manures (not counting guano) are certainly not less than a quarter of a million a year.

such an invention, and we will give, not £1000, but £100,000 for it. The result of the announcement has been applications from some two hundred claimants, all professing to have the article. But the prize has not been awarded, and has been withdrawn.

There is no dispute about the abstract value of solid night-soil, and of strong sewage water. Solid soil is extensively used by hop-growers and by market-gardeners round London, who buy it at a nominal price, and carry it back to their gardens without expense, in the waggons which have brought vegetables to market. Liquid sewage has been successfully applied to grass by gravitation alone in water-meadows and by London market-gardeners to a very limited extent, chiefly in dry weather. To their most profitable crops an artificial rainfall of sewage manure on the Chadwickian plan would be total ruin. Every effort was made by the Metropolitan Sanitary Commissioners, and by the first Consolidated Commissioners, the Trial Works Committee, and also the London Sewage Manure Company, to induce the gardeners to purchase sewage water, but they would not, because liquid manure hardens or crusts the soil they wish to keep loose and friable. At Manchester, in 1848-50, a sewage company was equally unsuccessful.

Many gardeners and florists employ strong liquid stable manure, as well as dissolved guano, with great effect, chiefly to plants in pots, with the power of draining completely out of the saucer, and to an extent in quarts on a surface of inches, which, if enlarged

to acres, would amount to tens of thousands of tons per acre. In fact, first-rate farmers, men of science with practice, use every kind of manure in its place at a price—solid and liquid, farm-yard, long straw, night-soil under special circumstances; but their mainstays are guano, nitrate of soda, superphosphate of lime, which no quantity of night-soil can replace. These artificial manures are applied to the crop with very little expense, as they are usually drilled into the soil at the same time, with the same horse labour, and often by the same machine which puts the seed in the ground.

The best farmers use the soil of their houses, mixed with ashes or loam, for root crops; but they do not forget a dose of superphosphate, applied with a water drill, in dry seasons.*

A ton of guano at £10 is cheaper than a ton of pure night-soil at 15s. Cider is not amiss now and then, but tons of Board of Health reports will not replace wine-cellars by cider-cellars.

As it is quite out of the question to introduce into the neighbourhood of London a pestilential marsh like that created by the "Foul Burn" at Edinburgh, it is part of Mr. Chadwick and Mr. Ward's plan to pump the sewage in pipes out of London, and send it in various directions to be retailed to farmers, who, however, would have also to sink some £6 per acre in iron underground pipes and steam-engines for pump-

* Prize Essay on Growing Root Crops, in the West of England Agricultural Society's Transactions, by J. Tanner Davey, Esq., Rose Ash, South Molton, Devon.

ing the liquid over their farms with jet and hose. Mr. Chadwick and his friends, in 1848, had very nearly concluded a bargain with Mr. Christopher Somers, a landowner in Essex, but were choked off by another Commissioner, Mr. Leslie, taking the levels, and proving that the sewer water must be pumped up 17 feet higher than St. Paul's, as a first expense. To support this theory of jet irrigation, let us see what reliable evidence we have. In Scotland, Mr. Kennedy, Mr. Telfer, and two or three other gentlemen, have grown vast crops of rye-grass with liquid manure on dairy farms; but their liquid manure is not diluted town sewage, it is carefully manufactured from the solid dung of sheep and cattle fed on boards under cover, *with the addition of large doses of guano and gallons of ammoniacal liquor* purchased from gas-works. The profit of this system is supposed to be derived from great artificial perennial green crops. They regulate very exactly the admixture of water; they apply solid manure and guano to their corn and root crops, and, as Mr. Morton, the editor of the "Agricultural Gazette," who has read an able paper on the "Cultivation of Italian Rye-Grass" by liquid manure, in 1855, once remarked, would not give twopence for any quantity of town sewage. But, after all, the results of subsoil-pipe steam-pumping irrigation are not encouraging. The most perfect example, Myremills, has failed, at heavy loss to the proprietor. Mr. Kennedy, the Manager, has sought a situation in the south, and the farm, unworked, wants a tenant!

Then, again, there are some English farms quoted

as stock examples by the Chadwick school; these are dissected in the following extracts from a letter to the "Journal of the Society of Arts," 25th May, 1855, by Mr. S. Sidney, of the Central Farmers' Club:—

"Mr. Chadwick accepts any evidence from any quarter favourable to his views,—for some ten years he has been labouring, without making any real progress, to substitute liquid manure for solid, and town sewage for the portable manures we owe to the guano islands and the discoveries of our chemists. He has inserted in the report of his speech a table, which has already done duty in 'Minutes on the subject of Sewer Water and Town Manure,' issued by the Board of Health. This table was prepared by Mr. Superintending Inspector Lee, in December, 1851, since which date many remarkable changes have taken place. I have followed in Mr. Lee's* footsteps over some of the principal farms mentioned, and have found his calculations, and still more his conclusions, based on statements as hypothetical as those of a traffic-taker for an intended railway.

"First, then, the Duke of Sutherland's Trentham farm, quoted as an example of hose-jet irrigation, was incomplete, and had produced no results when Mr. Lee visited it, consequently his calculations of the expense are mere guess-work. Mr. Lee has put down just what he pleased for machinery, coals, and wages of labour, so of course he obtains exactly the annual expense he requires. The next instance is Halewood,

* Mr. Lee is the gentleman who disreputably distinguished himself by first carrying on a secret correspondence with Mr. Hawkesley's clerk, in order to obtain his services to teach him how to devise water-works, and then by raising every kind of frivolous objection to Mr. Hawkesley's drainage plans for the city of Durham. Mr. Hawkesley is, without question, scientifically and practically, the first hydraulic engineer of the day; he discovered the formula for calculating the pressure of gas, and gave singular proofs of his peculiar talents by his calculations and formula in the atmospheric railway discussion. He has been treated accordingly by the official engineers of the Board of Health—one borrowed his clerk, and the other his plan for water-works. (See Charles May's, C.E., Letter to the Local Board of Health of Durham.)

Mr. Neilson's farm, and there I will be content with saying that none of Mr. Neilson's friends will think of referring to Halewood as an instance of successful farming. Next comes Liscard. I was at Liscard last year. The whole arrangements of that farm—a pretty fancy farm—were designed and executed under the direction of a friend of mine, Mr. William Torr, the well-known short-horn and Leicester sheep breeder, of Aylesby, in Lincolnshire.

“At Liscard, liquid manure is only employed for growing Italian rye-grass, distributed by hose and jet. Not a drop is applied to corn, although it might with ease. Mr. Littledale, the owner and farmer, largely employs solid farm manure, guano, and phosphates on his corn. Mr. Torr has laid out several other farms, besides two which he farms himself at Aylesby, where he has remodelled and rebuilt all the farm-buildings. He has not, either in his own or in those he has designed for others, adopted the pipe-and-jet system, because, he told me, ‘it would not pay, except for growing a mass of green crops for a dairy.’ Now Mr. Torr is not only a modern improving farmer, but a very clever mechanic. For further particulars I refer your readers to the discussion on the subject of the cost of liquid manure irrigation, at the Royal Agricultural Society's Rooms, last year, when the late Sheriff of Lincolnshire reported on the cost of irrigation on the Scotch farms.

“As to Mr. Lee's capacity to form an opinion on agricultural irrigation, I will only mention one illustration of it. I was at Exmoor water-meadows, mentioned in his report, three years after his visit. There a spring, brought from a hill above the farm, has been made by my friend, Mr. Robert Smith, to irrigate about eighty acres of a sloping hill behind the grange, after imbibing the manure of the farm-yard and house. Eighty acres are flooded in a quarter of an hour with no other machinery than a man, two boys, and three spades, as the water flows always down hill. Mr. Lee, like Mr. Chadwick, has such a superstition in favour of tanks, pipes, and hose, that he actually recommended Mr. Smith, much to his amusement, to substitute elaborate machinery for his effective rivulet

running down a hill. He repeats the same suggestion in the report I have been dissecting. It must be noted that Mr. Smith confines his liquid manure stream to grass crops—roots and oats he treats with solid. In the report on Somersetshire, published by Mr. Thomas Acland, a member of this Society, and one of the Editors of the Journal of the Royal Agricultural Society, he describes water-meadows made at from 20s. to £5 per acre.

“The official reports of the Board of Health, quoted by Mr. Chadwick with an authority to which they have no title, would lead to the conclusion that the use of liquid manure, underground pipes, hose, and steam-jet are rapidly superseding water-meadow irrigation, solid farm-yard manure, and the portable manures of Peru and of chemists. This is not the case. Never was there a time when farmers more readily and more rapidly adopted real improvements, whether chemical or mechanical or serial; but the use of sewage manure is not making progress, because the chemists and the guano merchants have beaten, and will beat, night-soil out of the market in every shape. Green crops are the only crops to which the hose-and-jet application of liquid manure has proved decidedly economical.”

We may add to this evidence, that the Rev. Mr. Huxtable,* who some time ago made a great sensation

* Mr. Mechi, the D'Orsay of agriculture, occasionally praises sewage manure; but, although Mr. Mechi is a witty speaker, a shrewd questioner, and an admirable retailer of commonplace agricultural truths, he is a very middling farmer, and far too hot and credulous to be a safe recorder of experiments. He alone maintains that liquid manure may be applied to corn crops, but then he has an agricultural paradox every year to cover the deficiencies his farm displays—a bad show of implements, very moderate root crops, wheat no better than his neighbours on the same soil, and miserable live stock. Mr. Mechi's last random assertion was a letter in the *Daily News* in November, 1855, stating that all the sewage of London could be distributed over 200,000 acres by a steam-engine no larger than a loo-table. As he did not say how high or in what time it was to be pumped, the comparison is as clear as that of “a cheese as big as a lump of chalk.” He talks well, but too fast.

by his agricultural experiments, has given up the use of liquid manure, which he formerly applied in the cheapest manner by wooden pipes without a steam-engine, the down-hill shape of his fields allowing him to use the force of gravitation, and has turned his tanks into receptacles for ashes, charcoal and other refuse, in which he finds it more economical and effective to absorb the liquid manure of his farm.

Beside the practical testimony above quoted, we have the advantage of an elaborate paper read before the Society of Arts, March 9, 1855, by J. B. Lawes, Esq., of Rothamstead, whose reputation as an agricultural chemist and agriculturist on a large scale is European.* Mr. Lawes gave the result of experiments carried on for years on the chemical contents of human excrement. Sewage manure, diluted and triturated through pipes, even according to Mr. Ward's plan for excluding rain-fall, would not be so powerful as manure collected in the farm-yard under cover with rain excluded. Mr. Lawes showed that with 180 lbs. of ammonia he grew, in 1854, 50 bushels of dressed corn per acre: it would require

* This paper, and Mr. Lawes' reply, exhaust the subject. As to who the author is—In July, 1855, he was presented with a testimonial—the subscription of 650 farmers and landowners,—being £1000 to build a laboratory, with a candelabra, £160. The candelabra bore the following inscription:—"Presented to John Bennett Lawes, Esq., as an heir-loom, at the same time with a laboratory, erected for him by public contributions on his estate, Rothamstead, Hertfordshire, in acknowledgment for the eminent services he has rendered to the science and practice of agriculture. July 19, 1855." We quote this from a Herts paper to show the value of our witness, because it is one of the ingenious devices of the Chadwick school to pick up such persons as Mr. Medworth, and call them scientific authorities.

17 tons of farm-yard manure to obtain the same quantity of ammonia, that is, fertilising matter, and that would not produce the same effect. Therefore half a ton of guano, worth £5 5s., or 7 cwt. of sulphate of ammonia, would be as cheap, and infinitely more effectual, than 17 tons of dung at 7s. a ton, and that would be the mere cost of carting solid manure for about 12 miles. Mr. Lawes calculated very exactly the dry substance of the excrements of one individual at 46 lbs. per annum, and the water supply, including rain, at 50 gallons per head per day, or $81\frac{1}{2}$ tons per head per annum, and that therefore a ton of water would contain about nine ounces of excrementitious matter; and he came to the following conclusions:—"That for corn crops an enormous supply of liquid manure is not well suited. Dry countries, where the summer passes without a drop of rain, are the great corn-producing countries, as, for instance, the Crimea, Southern Russia, Spain, and in England the east coast, which has several inches per annum less rain than the west coast. For market gardens it does not seem well adapted. That grass is the most suitable crop for the employment of liquid manure, but it must be employed in the *most liberal quantities that the soil and the season will admit of*, and that in this way it is not impossible that a rent of from £20 to £30 per acre might be realised" (by the landlord of land so irrigated). "There can be little doubt," he observed, "that it would require many thousand tons of sewage per acre to yield such a return; if 10,000 tons were applied, it would take 20,000 acres

to absorb the whole sewage of London at 50 gallons per head."

This suggestion of 10,000 gallons per acre agrees with the estimate of those most experienced in the use of water-meadows, also with the amount of sewage used in the water-meadows round Milan. Mr. Arthur Morse, in the discussion on Mr. Lawes' paper, considered, from his experience at Swaffham, that the sewage from 1000 inhabitants (which, at 25 gallons each per day, must be upwards of 40,000 tons a-year) could be advantageously placed on one acre.

Mr. Chadwick and Mr. F. O. Ward disputed and flatly contradicted Mr. Lawes' chemical and agricultural conclusions, as they do Mr. Stephenson, Sir W. Cubitt, and Mr. Bazalgette's and Mr. Haywood's engineering and mathematical conclusions, and both reiterated the old story of the Board of Health, that water, and therefore sewage, could be delivered 20 miles off by pumping power for $2\frac{1}{2}d.$ per ton; which is one-half true. Water can be delivered by water companies at the doors of houses in streets every day for a year at that rate per ton. But in the first place houses pay the expense of bringing the pipes within their houses, and in the next place they pay a rent for every day in the year.

Apply these terms to a farm, see what it will involve; the farmer or landlord must pay the expense or rent for pipes over each farm, and must pay, not for manure, as he requires it, not for a few hundred or a few thousand gallons in a dry season, when he requires it—that would be an excellent bargain—

but an annual rent for a material only available for green crops, say one-fourth of his farm.

This, on 10,000 tons, at $2\frac{1}{2}d.$ a ton, would amount to £83 6s. 8d. per acre. Divide in half, by allowing only 25 instead of 50 gallons a-day, and consequently 5000 tons as strong as 10,000, and it is still £41 13s. 4d.; an enormous sum for manure alone, which farmers engaged in dairies would usually prefer laying out on a home stock and portable manures. Twenty shillings an acre laid out in guano with water from the next well or pool, would be cheaper and more sure and effective.

It is out of the question for a Metropolitan Board to engage in land speculations—to become landlords or tenants of farms; the utmost a Board could do, would be to sell the sewage flow at a rent. What that rent would be remains to be proved. Guano, nitrate of soda, bones, dried South-American flesh, and superphosphate, can be sold to any extent, but sewage has no price in the market.

It is a remarkable and significant fact, that within the last fifteen years the farmers, the class whom Mr. Chadwick and Mr. F. O. Ward call “stupid and inert” because they will not purchase their patent brown draught—liquid sewage—have by their steady demand for chemical and mechanical improvements, increased the importation of guano and nitrate of soda to the utmost limits of supply, created a new flourishing manufacture to the extent of hundreds of thousands of pounds value per annum of artificial concentrated manures, and called into existence, in addition

to clever blacksmiths in every village, upwards of fifty English manufacturers of agricultural implements, employing steam power, and from 100 to 500 men in their factories.

We import guano and similar manures instead of using town sewage for the same reason that we import sugar, tea, coffee, cotton, and other staples of our commerce, because they are cheaper and better than anything we can grow at home.

Cities should first arrange to send their sewage where it will cease to be a nuisance; there sell it, if they can, but to give it away, if needful, but never spend one shilling in the hopeless task of competing with modern portable concentrated manures. It must always be remembered, when Mr. F. O. Ward's scheme for ripping up and re-sewering all the streets of London is under consideration, that from 1848 to 1854 the Board of Health has been endeavouring to force Mr. Smith of Deanston's sewage-manure notions on the public. Many towns have sewage-meters, but not one has been able to report a rent of £1, or even of 1s. a-head from the use of the precious stream. It is true that for several years we have heard of Rugby, where, in 1853, a gentleman farming 450 acres of land, took a lease of the town sewage, at £50 a-year, and had a tank and reservoir erected for his accommodation, with the privilege of using as much or as little as he pleased. In 1856, in the driest year known for forty years, he found it pay to pump water with sewage over his grass. At Exeter, a party was found to give £20 a-year, in

return for expenses amounting to £700, and the result was a most disgusting nuisance, when reported on, in 1853, but no crops.

If sewage should come extensively and permanently into use for grass land near Barking Creek or Plumstead Marshes, there will be no difficulty in securing the rent it is proved to be worth.

A manufacturing, pumping, piping, farming sewage scheme might make a Commissioner a C. B., and a pensioner of Mr. F. O. Ward, but it would be a new event in the history of municipal boards if it made a profit. The safe side is to adhere to the opinions of eminent engineers, chemists, and agriculturists, and leave the amateurs to prove their experiments in grass plats and geranium pots.

We have devoted a good deal of space to this sewage-manure question, because it is the foundation of a number of most foolish and costly schemes, which have ended, and will end, in the serious discouragement of intelligent plans for sanitary reform. The General Report of the Board of Health, from 1848 to 1854, makes no mention of the numerous failures which its officers have experienced in attempting to draw profit from sewage-manure. The end of that Report contains (pp. 92-93) "Conclusions on the Application of Sewer Water and Town Manure to Agricultural Production." These conclusions in 1854 are merely a repetition of the theories of Mr. Smith, of Deanston, in 1844, and in every instance grossly exaggerated or absolutely untrue. But this is one of the documents printed and circulated for public

information, at public expense! In these "*conclusions*" liquid manure is recommended "for arable cultivation," and steam-power and jet are stated to be more *economical* agents for distribution than water-meadow irrigation; and that "6s. per acre rent for pipes will give the fertility of three or four additional farms upon one." All evidence and all experience, as we have shown, prove the absolute fallacy of these statements. In another Board of Health table, which Mr. Chadwick is fond of quoting, the cost of making water-meadows is brought up at £20 to £40 an acre, by choosing the most expensive examples in England, while iron pipes, omitting the heavy charges for wear and tear of hose and labour, are set down at £4 to £5 an acre. Thus it is always with Mr. Chadwick's comparisons: to prove his own case, he picks out the cheapest instances, omitting all extras and contingencies, and selects the most extravagant instance on record, such as the Duke of Portland's water-meadows at Mansfield, to exhibit the average of the other side of the question. If, in this water-meadow instance, we turn from the Board of Health Report to the Journal of the Royal Agricultural Society for 1853, vol. xiv. pp. 154 and 432, we find a description of Mr. Bickford's irrigation plough and system of water-meadows. Mr. Druce, of Eynsham, Oxfordshire, a well-known breeder of Down Cotswold sheep, and exhibitor at the Smithfield Club Cattle Show, writes:—"The cost for the laying out was 15s. an acre, and 10s. an acre more for extra labour in removing turf

and levelling the ground and pipe-tiles to convey the liquid manure from the homestead; and the future annual cost will be from 2s. to 3s. an acre. One man pumping and one man regulating manage the whole business." Why, Mr. Chadwick's 6s. per acre will barely pay for wear and tear of hose in a rough, flinty country. On dairy farms it may pay to pump the liquid manure of the farm on to the green crops grown for cutting round the farm buildings; but the rent-paying crop of England, in all but a few districts, is the corn crop, and the finest crops of corn are grown in the counties that have the least rain, and the finest harvests are reaped in the driest seasons. It is a significant fact that Warnes's system of manufacturing solid manure, by feeding cattle in boxes, at a considerable expense for buildings and for labour in attendance, has made rapid progress in the same period (about ten years) that the late Board of Health endeavoured vainly to supersede solid by liquid manures; and that while the liquid manure drill for sowing only is coming into common use among practical farmers, the pumping pipe system remains the amusement of a few rich amateurs.

CHAPTER IX.

A DESCRIPTION OF THE WATERWORKS OF THE METROPOLIS.

THE waterworks of London are not perfection. They were not planned last year, or ten years ago. They have grown up by degrees, following the growth of the great city during a succession of years, in which the habits, tastes, modes of life, manner of building, paving, and draining have been essentially changed and improved. But whoever takes the trouble to examine the London waterworks as a whole; to mass together in his mind the vastness, the multiplicity, the power, the regularity of their operations, will certainly admit that, considering the adverse circumstances under which many of their essential operations have been carried out, they are in the highest degree creditable to the enterprise, the ingenuity, the scientific and the mechanical skill of the men who planned and executed them.

For the drink, the washing, the manufacturing, the street cleaning, the drains and sewers of the habitations of two millions of souls, sixty million gallons of water are poured into London every 24 hours, by steam-engines of the collective force of at least 3000 horse-power, by establishments representing a gross capital of nearly £6,000,000 sterling,

raised by private enterprise, without the aid of those exclusive powers and monopolies which in foreign cities have always been extended to works of public utility.

Some ten years ago a loud complaint was made, not without reason, of the quality of the water supplied by the London companies, on the ground of impurity and of short supply, especially in districts where ancient pumps having been removed by modern improvements or spoiled by modern sewerage, landlords declined to pay water-rents for poor tenants, with whom, consequently, dirtiness became chronic.

The Commissioners of the Board of Health, looking hungrily round for more power, more patronage, and something that would give them a perpetual lease of office when the cholera panic had passed by, projected another illustration of the "reverse of wrong fallacy" by proposing to purchase all the metropolitan waterworks, and consolidate them into one "Centralized Water Board," offering as a bribe a prize—a "new system," and a "new source of water supply."

Now as to the then polluted state of the water of several companies, that was unquestionable. It must be remembered that all the sources of supply were originally pure. The Companies did not go to the pollution, the pollution came to them. The public growing more civilised and luxurious, adopted water-closets and sewers instead of the "gardy loo" of Edinburgh, the scavenger's cart and the dry cess-pool, and turned the sewers made for rain into the Thames.

Up to a certain point, whatever zealous doctors and chemists may say, there can be no question but that the chemistry of nature exercised in a flowing stream is sufficient to render impurity harmless. If scientific purity were essential for the health of water-drinkers, the whole race of shepherds and herdsmen in both hemispheres who drink from streams where leaves fall and weeds grow, ought to be swept off by an epidemic annually.

At the time when the first advent of the cholera called attention to every external source of disease, there is no question but that the sewerage of the population on the banks of the London Thames had completely overpowered the natural tendency of water to run itself pure, and the same offensive causes had been in operation in the river Lea.

Fortunately, private enterprise and rising distrust of Government Boards proved too strong for the official centralisation of Mr. Chadwick's amateurs; and the London Water Companies, after being prevented, for several years, from undertaking any great works by the uncertainty of their position, received, in 1852, under a set of Acts of Parliament, a new lease, upon certain conditions. These conditions have been, in a great measure, performed; and, before entering into an examination of the theories of water-supply which are still from time to time brought forward by the aspirants for a reorganisation of the Board of Health, and by the medical and chemical seekers of Government patronage, it may be useful to clear-away the stock-in-trade of those agi-

tators who quote past pollutions, and ignore the present practically pure condition of metropolitan water supply. We propose to begin by describing the present condition of metropolitan water supply; and afterwards proceed to consider the vexed questions of "Constant Supply," and the "Sources of Supply."

Since 1852, there has been expended, or is in course of expenditure, on the improvement of existing Water Companies' works, a sum exceeding two millions sterling.

The Chadwickian agitation of 1850—an agitation carried on with the most selfish views, in the most unscrupulous manner—was founded on an engineering plan of "gathering grounds," which would have left London entirely without water for ten months in 1855. Yet it did good in one sense, by stimulating the activity of the Water Companies, and awakening the attention of the public to the value of an ample supply of pure water. But long previous to that date the Water Companies had steadily followed, if they had not kept pace with, the demands of the age. For we must remember that what are the luxuries of one generation are not unfrequently the necessities of the next; that the habitation which the Black Prince would have considered luxurious, if offered to one of our stokers or engine-drivers would be rejected with indignation.

Sir John Rennie, in his presidential address to the Institute of Civil Engineers, gave a summary which affords in a few words a great deal of information:—

“Waterworks.”—In the supply of that important necessary of life—water, which was so much studied by the ancients, but so greatly neglected in the middle ages, great progress has been made in modern times. Spring-water was formerly conveyed to public reservoirs in the City of London, by leaden pipes from various springs in the vicinity: viz. from Tyburn in 1236, from Highbury in 1438, from Hackney in 1535, from Hampstead in 1543, and from Hoxton in 1546. For these useful works, the citizens were indebted to the munificence of several Lord Mayors and other individuals, but those of Hampstead and Highgate are the only ones now remaining. The open watercourse or conduit from Dartmoor, 24 miles long, for supplying Plymouth with water, commenced by Sir Francis Drake, in the reign of Elizabeth, and the New River, for the supply of London, 39 miles long, 28 feet wide, and 4 feet deep, falling 3 inches in a mile, by Sir Hugh Myddelton, in 1613, are considerable works of the kind, and were planned and executed at the cost of those distinguished individuals. Myddelton was, in fact, ruined by it, and adopted the profession of an engineer and surveyor to obtain a livelihood.

“London Bridge Waterworks were commenced by Peter Moryce, in 1582, with water-wheels turned by the flood and ebb current of the Thames, passing through the purposely-contracted arches of Old London Bridge, and working pumps for the supply of water to the metropolis; it was the earliest example of public water service by pumps and mechanical power, which enabled water to be distributed in pipes to dwelling-houses. Previously, water had only been supplied to public cisterns, from whence it was conveyed, at great expense and inconvenience, in buckets and water-carts. In addition to the London Bridge and New River, several minor establishments of the same kind were afterwards erected on the banks of the Thames, to supply separate districts in their immediate vicinity. Some were worked by water-wheels on the sewers which discharged themselves into the Thames; others, by horses; and one by a wind-mill. That at Broken Wharf in 1594, at Shadwell and York Buildings, worked by horses, and at Chelsea by water-wheels, may be mentioned. Early in last century, when the old cisterns had

nearly disappeared, and water was supplied to the dwellings, a great improvement took place, by the application of the steam-engine (which had then begun to develop its extraordinary powers) to the York Buildings Waterworks by Savery, in 1710, and afterwards by Newcomen in 1730. Newcomen's engines were subsequently applied at Chelsea, Shadwell, Stratford, London Bridge, and the New River Waterworks. As soon as Watt had brought his improvements into operation for pumping water, his engines were applied at each of the above waterworks by degrees, in addition to the old engines: thus a comparison between them could easily be made, and soon showed the superiority of Watt's engine in every respect. They were thus applied at Shadwell and Chelsea Waterworks in 1788, at London Bridge and Lambeth soon after, and at the York Buildings in 1804. The usual mode for the old engines was to pump the water into a cistern, at the top of a high tower, and from thence it descended through pipes, to the districts and buildings where it was required; the engine was thus always kept to its full load, whether necessary or not, and a waste of power ensued. Air-vessels were afterwards added to the pumps at Chelsea, and subsequently became general; the air in the vessels being compressed, acted by expansion and contraction on the water, so as to force it with regularity through the pipes, without going up to the cistern. Smeaton, who had constructed water-wheels for pumping at Stratford in 1763, and at London Bridge in 1767, where towers were employed, afterwards became the principal proprietor of the Deptford Waterworks, and in 1773 constructed a water-wheel for pumping water from the Ravensbourne without a tower. The machine is still in existence, although steam-engines have been subsequently applied. About 1810, Boulton and Watt's improved pumping-engines, constructed wholly of metal, and erected in handsome substantial buildings of brick and stone, with large air-vessels for pumping direct into the pipes, became generally adopted at all the London waterworks; cast-iron pipes were substituted for the old ones of wood. The new engines being more powerful, and the cast-iron pipes stronger, enabled water to be distributed to cisterns on the tops of

dwelling-houses, hence denominated the high service. Stone pipes were tried at the Grand Junction Waterworks, but failed, and iron pipes were substituted. Filtering reservoirs upon a large scale were constructed at Chelsea by Simpson in 1830, and subsequently at other places, with complete success, and are now universally employed. The water is now generally taken from the Thames above the town, where it is least adulterated. The old waterworks lower down the river, viz. York Buildings, London Bridge, the Borough, and Shadwell, have been abandoned, and new places chosen at Hammersmith and Brentford, higher up the river, and at Old Ford upon the river Lea; the river water is received into capacious settling or filtering reservoirs, and distributed by steam-engines to the respective districts. Latterly, powerful condensing steam-engines, very similar to Watt's, but worked by high-pressure steam with great expansive action, on the system introduced by Woolf, in Cornwall, for deep mines, were introduced by Wicksteed, in 1840, at the East London Waterworks, and have since been adopted by other Companies with advantage in saving fuel. The double cylinder high-pressure condensing engine, with great expansive action, on the system of Hornblower, have also been introduced by Woolf, Hall, and Rennie, and applied to work mills with success. Waterworks, similar to those in the metropolis, have been erected at Edinburgh, Glasgow, Dublin, Manchester, Liverpool, and all the principal towns in the kingdom. At Glasgow, one of the last engineering efforts of Watt was to suggest the idea of laying a pipe under the Clyde, to bring water to the city from the opposite side of the river; this was to have been effected by making the pipe with flexible ball-and-socket joints, uniting the whole together in one piece, and closing it at each end, floating it to its position, and sinking it. Rennie effected a similar operation at York Buildings in 1810. The increased means for the supply of water, and the economy and punctuality with which it is distributed, has occasioned a greater consumption, and induced a degree of cleanliness throughout all classes, which has tended to augment the comfort and health of the community. Still

the system is capable of improvement; larger reservoirs and more copious supplies are necessary.

“In carrying out the improvements above mentioned for the supply of water, the names of Smeaton, Watt, Mylne, Rennie, Telford, Simpson, Bateman, Anderson, Clark, Wicksteed, Walker, Martin (and we may venture to add Hawkesley), and others, must not be forgotten; and we shall no doubt witness efforts upon a still greater scale in future.”

And in 1854, Mr. James Simpson, the Engineer of the Chelsea, and also of the Lambeth, Waterworks, in his presidential address, observed:—

“It has been asserted that few improvements have been introduced into waterworks, during the nineteenth century, but it is not difficult to prove this assertion has no real foundation. The introduction of cast-iron pipes, in large quantities, for water-work purposes, may be dated from about the year 1810, prior to which period wooden pipes were principally used for water services in the streets. Although some of the waterworks had previously employed iron pipes, to a limited extent, they were principally confined to the mains, or larger conduits, owing to the high price of iron, and to the difficulty of obtaining any considerable quantities of pipes. The first iron pipes were laid down by the Chelsea Waterworks Company in 1746, and the ironfounders of that period would not undertake to deliver more than twenty pipes of 12 inches diameter per week, or less than one-tenth of the capability of a third-class foundry of the present day: thus it is evident that the high price and the small supply of iron pipes tended materially to prevent the establishment of waterworks on an improved and extended scale.

“Before the year 1810, very few towns were supplied with water at greater elevations than 10 feet above the pavement of the street; a common water-butt, in a back yard, was then the usual receptacle for a house supply, and it was only in the mansions of the wealthier inhabitants that cisterns were to be

found. High services, however, quickly followed the more general introduction of iron pipes for conveying the water, and the inhabitants were not tardy in availing themselves of better and more accessible supplies of water, for all domestic purposes.

"It was not possible to keep the wooden mains and pipes constantly charged with water, for supply in cases of fire; but by the adoption of iron pipes this was readily accomplished, and, with the power they afforded of increasing the pressure, and of laying on high-service supplies to houses, so as to enable the water to be delivered on every floor, that system was by degrees introduced.

"Between 1810 and 1830 great changes were successfully introduced into the system of the supply of towns; more commodious and complete reservoirs were established, the street pipes were improved, and the whole of the minor working details were more closely adapted to the wants of the day.

"In the year 1828 filtration on a large scale was applied, under my direction, at the Chelsea Company's Works; the previous examples of the kind being confined to Glasgow and to a few dyeworks in the manufacturing districts.

"The steam-engines and pumping machinery employed have also been rendered more economical, and improvements have been introduced to keep pace with the requirements of the public for increased and more constant pressure, and during the last ten years attention has been paid to the quality of the water, to its filtration, and to covering the service reservoirs."

With respect to the improvements commenced, and in course of early completion, we avail ourselves of the information contained in a series of papers which have recently appeared in a very able, practical, and scientific journal* (omitting all the technical terms and descriptions), with certain additions, the result of our own personal observation.

* "The Journal of Gas Lighting and Water Supply," Feb., 1855, *et seq.*

The *Chelsea Waterworks* afford a fair example of the future condition of metropolitan water supply under the management of an engineer of great practical scientific experience.

They have been partly, and in the course of the month of June and July will be entirely, removed from their ancient sites on Chelsea Reach to Seething Wells, Ditton, one mile and a half from Kingston-upon-Thames; three miles above the action of the tides, at a spot where the river, dammed up by the lock at Teddington, flows constantly in one direction, a concrete wall, eight feet thick, has been built along the river face for 2500 yards, being the whole extent of the Chelsea and a timber piling opposite the Lambeth works, which are close adjoining, and under the management of the same engineer.

The first operation for obtaining a supply is to open a sluice in the concrete wall, and permit the river water to flow into two open reservoirs, where it remains for twelve hours to settle. It is then drawn off into the filtering-beds. After years of experiments, it has been found that gravel and sand make the best filters.

These beds are constructed by laying down over earthenware drain-pipes pierced with holes, *first*, a layer of coarse gravel, obtained by dredging the river—of pebbles, in fact; *secondly*, a layer of finer gravel; *thirdly*, a layer of sea-shells imported from Harwich; *fourthly*, a layer of coarse sand; and, *fifthly*, one of fine sand. The shells overlapping prevent the sand from sinking into the pipes.

To separate the gravel and sand into four sizes, a huge screening-machine, in shape not unlike a coffee-roaster, worked by a small engine, which is also applied to many other minor purposes, is used. This machine is divided into three cylindrical compartments, of which the centre is of the coarsest iron network, and the outside the finest; the centre having been filled with dredging stuff, the machine is turned slowly round, while a stream from a hose is directed into it, and as each compartment is filled, coarse gravel, finer gravel, coarse sand without any admixture of pebbles, and fine sand, roll out, each to its separate heap.

This machine is also used for re-washing the materials of the filter-beds when required.

The two filter-beds are constructed with undulatory surfaces and a wall between them.

After draining through the five layers, which effectually clear the water of every impurity held in suspension, it flows into a well 9 feet in diameter and 18 feet deep. Four steam engines, each of 150 horsepower, attached to metal pumps, are in connection with this well, and two engines working at a time drive the filtered stream through a line of iron pipes 30 inches in diameter, extending from Kingston to a reservoir at Putney Heath, 170 feet above the Thames. To such perfection have these pumping engines been brought, that standing outside the doors of the great hall that covers them while they are in full work, scarcely a sound can be heard of the steady pulsa-

- tions of one of the hydraulic hearts of London—600 horse-power working without a gasp or sigh.

The filters are cleaned alternately every month, by lying dry, and scraping half an inch off the surface. Twice a-year the sand is dug over and fresh material added. The main to Putney Heath passes over several streams on its way, and has paid large tolls by way of compensation for purely imaginary injuries—such is our English system,* and, after leaving Putney, crosses the Thames on a viaduct of screw piles through and over the villa where the unhappy author of “Gilbert Gurney” once lived.

At Putney the filtered stream is received into two covered reservoirs or crypts, with brick arched roofs, covered with layers of earth and green turf. From this dark cool receptacle, filled and emptied every twenty-four hours, ten million gallons of water will, in future, flow daily, by the force of gravity, throughout the whole district supplied by the Chelsea Company.

Alongside the covered crypts an open reservoir, containing 2,500,000 gallons, supplied by a separate main, direct from the settling reservoir without filter-

* A public company is a public sponge for the extortionate squeezings of landowners, just as the windows of an empty house are a mark for the stones of idle boys. The very class of landowners who benefited enormously either by the improved value given to their estates by improved means of communication, or by compensation for land taken, or for severance, or by improvements in drainage, roads, and bridges, made at railway expense and very often by all these profits and advantages, are the very class who are loudest in complaining that the railway charges of England, with its dear labour and heavy local taxes, are higher than those of the Continent, where companies buy land for agricultural prices, have no competition to encounter, and no local rates to pay.

ing, has been provided for sewer flushing, street and road washing, and other similar purposes.

The total cost of the improvement executed by the Chelsea Company, between 1852 and the present time, exceeds £400,000.

The Lambeth Works, as already observed, are close adjoining the Chelsea, and have been in full operation for four years past. They are constructed, as to their filtering and pumping arrangements, very nearly on the principles and plans just described.

After passing through the Lambeth filters, the purified water passes into the wells from which it is driven into the main, into the covered reservoirs of supply. The 1st of these, at Brixton, distant $10\frac{3}{4}$ miles, has an area of 3 acres, and stands 110 feet above Trinity high-water mark. The 2nd, at Streatham, at an elevation of about 185 feet, has an area of about $1\frac{1}{2}$ acre. A 3rd reservoir is proposed to be constructed at Rockhill, at an elevation of 360 feet, for the supply of the Crystal Palace and the villa districts round Sydenham.

The total outlay of the Lambeth Company for the improvement and increase of its supplies is estimated at about £300,000.

Three Companies, the *Southwark and Vauxhall*, the *Grand Junction*, and the *West Middlesex*, have established their works about three miles above the Chelsea and Lambeth, on the opposite or north side of the Thames, in the parish of Hampton, opposite to Platt's Eyott, an island which separates the navigable branch of the Thames from the bye-wash, or flood

channel. The three Companies occupy altogether about 22 acres, and derive their supply from this point, which is above the second lock upon the artificial navigation of the Thames. The Grand Junction Company and the West Middlesex have combined for the purpose of forming their impounding reservoirs, and have constructed settling reservoirs; but the West Middlesex allows the water to flow into the pumping well of its engine without this preliminary clearing process.

The pumping work for the three Companies is done by three engines of precisely the same model, each of 110 nominal horse-power; each engine, when in full ordinary work, being able to discharge 10,000,000 gallons in 24 hours. The filtering station and reservoir of the Southwark Company is in Battersea Fields, $13\frac{1}{2}$ miles from Hampton; that of the Grand Junction at Kew, at a distance of $7\frac{1}{2}$ miles; that of the West Middlesex at Barnes, at a distance of $8\frac{1}{2}$ miles.

The establishment of the Southwark and Vauxhall Company in Battersea Fields consists of two settling reservoirs, of the respective areas of 84,000 and 144,000 superficial feet; the water passes over the whole length of these two reservoirs before it flows into three filter-beds, of the respective dimensions of 35,000, 86,000, and 76,000 feet superficial. The depth of water varies from 13 to 16 feet. The present demand for purified water is at the rate of ten million gallons per 24 hours. From the filtering-beds the water, perfectly cleared, passes to the pumping-wells, where three engines pump it over the lofty

iron "stand-pipes" that form the most conspicuous object in Battersea Fields; and from the height of these "stand-pipes"—about 190 feet above the level of the pumping-well—the water is distributed without resting in any reservoir, by the force of the engines, some of which are pumping night and day.

The Southwark Company have purchased 14 acres of ground near Nunhead Hill, Peckham, on which they propose to form two reservoirs. The improvement works of this Company will cost, when completed, about £200,000.

The West Middlesex Company establishment at Barnes consists of two subsiding reservoirs of 16 acres, and three filter-beds of 4 acres. From the filter-bed the purified water flows through a cast-iron pipe passing under the river Thames to Hammersmith, where four engines, with a total nominal power of 595 horses, pump it to a covered reservoir at Little Barrow Hill, near St. John's Wood, 287 feet above Trinity high-water mark.

The West Middlesex Company have also purchased a plot of land near Kiderpore Hall, Kilburn, for the purpose of eventually forming an additional reservoir, at 287 feet above Trinity high-water mark. The average quantity of water supplied is not less than 208 gallons per house per day.

The total outlay for their improvements is estimated at about £170,000.

"The Grand Junction Waterworks' Company have formed their filtering establishment at Kew, close to their old pumping-station. There are two settling reservoirs, one of 90,000

and the other of 180,000 superficial feet, and three filter-beds of 80,000 feet superficial, each. The engine power even now existing at these works is equal to about 820 nominal horse-power; and it is proposed still further to increase it to the extent of 170 horse-power additional, in order to force the water to a new reservoir about to be formed at Camden Hill, at a level of 156 feet above Trinity high-water mark, and of a proposed capacity of 6,000,000 gallons.

"In addition to the works thus described, and the supply establishment at Hampton, the Grand Junction Company have commenced the construction of an engine-house at Camden Hill, to receive three engines similar to the one last mentioned, for the purpose of forcing water to a second reservoir, for which they have purchased 33 acres of land at Shootup Hill, at a height of 276 feet above Trinity high-water mark. There are at Kew already 7 boilers, but it is intended to increase this number to 12. At present the water supplied in the district of this Company passes over the large stand-pipe at Kew, and the engines are worked day and night. The stand-pipe itself is about 215 feet above Trinity Datum. It is calculated that the Grand Junction Company supply about 250 gallons per dwelling-house on the average of their district; but that, if no deduction be made for street-watering or large consumers, the average per house would amount to the enormous quantity of 345 gallons."

The outlay for improvements by the Grand Junction since 1852, will amount, when the works in progress are completed, to £200,000.

The *New River Company*, which absorbed the fortune and immortalised the name of Sir Hugh Myddelton as the founder and pioneer of English waterworks, has in course of execution and nearly completed a series of improvements and additions on a vast scale.

A system of sewers has been carried out in Hert-

ford by which the sewerage of that town is intercepted from the rivers Lea and Bean above the point at which the New River obtains its supply, and also the erection of a series of drains, culverts, and syphons, for the purpose of intercepting various surface streams which previously polluted the pure chalk springs from which the main volume of the Lea is fed. With a view of increasing the rapidity of the flow the course of the river has been straightened.

At Stoke Newington the old depositing reservoirs have been deepened, and from them conducted through a new cut to a series of five filter-beds, with a surface of $6\frac{1}{2}$ acres, capable of filtering 1,250,000 gallons in an hour. From these filters the waters pass into a covered reservoir capable of holding 1,750,000 gallons.

In the pumping-house close at hand are six engines, with a collective force of 1000 horse-power. Four of these engines, of 150 horse-power each, are to work pumps for the supply of a reservoir in Maiden Lane, about 133 feet above the Stoke Newington filter-beds, other two are to pump the water into a covered reservoir at Claremont Square, Islington, after supplying the district below the level of that deriving its supplies from the Maiden Lane reservoirs; the water is raised to a square tank, situated at a maximum elevation of 196 feet above Trinity high-water mark, and, flowing thence, supplies the district to be served by gravitation.

“ The total expenditure for this gigantic engine establishment has not been less than £92,000, whilst that of the mains

connecting it with the reservoirs and tanks has been about £60,000 additional.

“ The Maiden Lane reservoirs are situated between Highgate and Holloway, not far from the new Fever Hospital. They consist of two covered reservoirs, each of which is 273 feet in length, by 208 feet in width; the average depth of water will be 22 feet, and, when full, they are calculated to contain about 7,500,000 gallons each of filtered water. When the water is at its maximum height, its surface will be 220 feet above Trinity high-water mark. The cost of the reservoirs themselves, when complete, exclusive of the land, will be about £61,000.

“ The Claremont Square reservoirs are constructed in the same manner as those at Maiden Lane, upon the site of the ancient open reservoir which supplied the north-western part of London. They will be 176 feet long, by 180 feet wide, and 22 feet deep; the maximum level of the water being 117 feet above Trinity high-water mark. They will be supplied from the filter-beds at Stoke Newington, and from the filters constructed at the original New River Head. Exclusive of land, these reservoirs, which are intended to hold 3,500,000 gallons, will cost about £22,000.

“ At the New River Head, considerable changes have also been made. One of the original reservoirs has been converted into a filter, in three distinct divisions, but presenting a total water surface of $2\frac{1}{2}$ acres, which is calculated to filter at the rate of 540,000 gallons per hour when all three beds are at work. The old circular pond has been lined and altered, so as to enable it to act as a feeder to the filters; and the engines have also been altered, so as to suit the new conditions of the supply. Exclusive of the cost of the land, these works have entailed an outlay of at least £34,300. The engine power consists of two old engines of 150 horse-power each, and one smaller one, which is only occasionally used. So that the total cost of the new filter-beds, engines, engine-houses, reservoirs, and mains for their supply, have not been less than £351,960. If to this be added the cost of the land recently

purchased, the outlay upon the sewerage of Hertford and Enfield, the rectification of the channel, and the alterations in the service mains, the outlay of the New River Company, in carrying out, not the mere letter, but the spirit, of the Act of 1852, cannot be estimated at less than £500,000.

“ In addition to the works above-mentioned, this Company has engines placed at Ware, Amwell, and Cheshunt, for the purpose of pumping water from some deep-seated wells in dry seasons, when the Lea is not able to furnish a full supply; there is another engine at Tottenham; two more engines are placed near the reservoirs, and a small one at Highgate; making the total steam-power occasionally used by this Company 1419 horses.”

The *East London Waterworks Company* have expended £250,000 in the following works. They have constructed an intercepting culvert, which excludes the sewerage of the parishes of Enfield, Edmonton, Tottenham, and Hackney, and a new conduit from the tail of the copper-mill to the filter-bed. A series of 13 filter-beds, including 12 acres, has been constructed upon the site of the Old White House, at Lea Bridge, six on the east and seven on the west bank of the river. From these beds the water flows through cast-iron pipes to the various pumping wells. The old cut from Lea Bridge, the settling tank and circular pond, are entirely abandoned, and the supply is rendered direct from the engines; thus rendering atmospheric contamination all but impossible. The Cornish engine at Lea Bridge, constructed by Mr. Wicksteed, is supposed to be one of the largest in existence.

The *Kent Waterworks* are situated at Deptford, on the Ravensbourne, and have the supply of a district a

large portion of which is rapidly turning from purely rural to thoroughly suburban. They have expended since 1851 about £70,000 in covering over one reservoir, constructing and improving settling reservoirs and filter-beds, the former having an area of about four acres and a half, and the latter of three acres; which enables them to filter about 2,000,000 gallons per acre per day so effectually, that the waters of the Ravensbourne, when, from the effect of land floods, "turbid as pea soup," passed into the pumping-wells "so clear that a coloured pebble could be distinguished at the bottom through 10 feet of water." The Engineer of the works, Mr. Morris, has also sunk two wells, the one with a bore-pipe sunk 110 feet, the other with a 12-inch bore to a depth of 200 feet, from which an ample supply from the chalk can be obtained if required.

The result of these improvements has been to render the water supplied everything that could reasonably be desired.

"The Plumstead, Woolwich, and Charlton Waterworks derive their supply from two wells, sunk through the basement beds of the London clay, the waters from which are carefully excluded by means of close iron cylinders, into the subjacent chalk stratum. One of these wells is carried down to the depth of about 139 feet from the surface of the ground, or 64 feet below Trinity Datum; and nearly at the bottom some galleries have been carried into the chalk. The other well does not continue of the full diameter to any great depth; but there is, at the bottom, a bore-hole, 6 inches diameter, carried to a depth of about 525 feet below Trinity Datum. When in full work, the former yields about 600,000 gallons per day, and the water rises at a constant temperature of $49\frac{2}{10}^{\circ}$; the latter,

or the bore-hole, yields about 200,000 gallons per day, the water rising at a temperature of $58\frac{2}{6}^{\circ}$; the temperature of the mixed water in the reservoirs generally ranges about 52° . The increase of temperature in this case does not appear to exceed 4° in 461 feet; but the result here observed can hardly be referred to as throwing any valuable light upon this subject, because it is questionable whether the water obtained from the galleries derives its temperature from that of the chalk at their level, as is likewise to be observed with respect to the water from the bore-hole.

“From the pumping-well the water is conveyed to a series of three open reservoirs, where it is softened, by the first application, on a large scale, of Dr. Clark’s process for removing the excess of the bicarbonate of lime in solution in all well-waters in the chalk. The engine and boiler houses have been erected with a view to place in them ultimately two steam-engines, but at present only one has been erected. The nominal power of the engine is 35 horses, but it is stated frequently to work up to 110 horses, according to the indicator.

“In its passage from the well to the softening reservoirs, the water meets and carries forward a jet of cream of lime, regulated so as to be slightly in excess of the quantity required to deposit the carbonate of lime in solution in the water it is immediately mixed with in the pipes, but which quantity is strictly that necessary to soften the whole quantity contained in the reservoir. The lime is, in fact, mixed at first slightly in excess, and the pure chalk-water necessary to establish the chemical balance, so to speak, is subsequently added; for it was found, practically, that the softening process was effected more expeditiously by adopting this course than by mixing at once the lime theoretically required. Each of the three softening reservoirs is designed to hold 280,000 gallons, and there are all necessary provisions made for clearing out the deposit, and for securing the clearness of the water which finds its way into the pumping-well; but the reservoirs are left uncovered, and are exposed to receive the falling leaves and other atmospheric or mechanical impurities. When the water flows into these reservoirs during the mixture with the lime, it is of a

perfectly white colour; after standing, however, for twelve or fourteen hours, the lime thus added, and the bicarbonate of lime in solution in the chalk-water, are thrown down in the form of an insoluble carbonate of lime of the greatest purity, and most brilliantly white colour. It was expected that the application of this singularly beautiful and simple process would have reduced the hardness of the water to a greater extent than it really has done; at present the hardness, as the water leaves the reservoirs, is about 7° of Clark's test—the average hardness of the other waters distributed in London being about 16° of the same scale. We may add, however, that so perfectly limpid and clear were the waters before being admitted to the pumping-well for distribution, that we could easily distinguish objects at a depth of twelve feet from the surface; and the whole mass had the peculiar blue tinge so characteristic of the waters of the Lake of Geneva, or of similar lakes. The taste was remarkably pure; but, owing to the absence of carbonic acid gas, it was flat. If, however, this peculiarity rendered the water less agreeable for drinking purposes, it must also diminish the danger attached to its storage; for neither vegetable nor animal aquatic life can develop themselves in waters deficient of the pabulum of the confervæ or other water-plants.

“The water is pumped directly into the supply mains; but there are two regulating storage reservoirs, one of which is situated on Plumstead Common, at an elevation of about 160 feet above Trinity Datum, and the other at Shooter's Hill, at an elevation of about 330 feet. The capacity of the former is equal to 700,000 gallons: it is covered with brick arches, springing from cast-iron girders, supported on cast-iron columns, and covered with a coating of impermeable materials of sufficient thickness for the purpose of maintaining a constant temperature in the interior. The upper reservoir is designed to hold 400,000 gallons, and is constructed upon precisely the same system, but it has not hitherto been used. At present, it appears that the quantity actually supplied by this Company to its tenants is equal to about 410,000 gallons per day, and the mode of house distribution is that known as

the constant service. Originally the supply was so ; that is to say, it was constant—‘on’ day and night ; but the waste of water soon became so serious that the Company has, in self-defence, been obliged to limit its hours of delivery—a result which we fear will always be the case, unless the whole of the details of the house-fittings be executed under the direct control of the engineers of the waterworks. At Woolwich they were executed under the control of the officers of the General Board of Health.

“As will be seen from the above description, the principal interest attached to the Plumstead Waterworks is that connected with the application of Dr. Clark’s process for softening waters containing a notable proportion of the bicarbonate of lime. Unquestionably for many uses of life, waters of 20° of hardness are very objectionable ; but when this hardness arises from the presence of a salt which can be thrown down by mere boiling, the advisability of adopting Dr. Clark’s system must depend upon the cost at which it is effected, supposing always that no injury to the health of the population consuming the water be effected by depriving it of the carbonic acid gas, usually considered to be a great stimulus to digestion. It is stated that the carbonate of lime deposited in the softening reservoirs of this Company, constituting, as it does, a whitening of the best and purest description, could be sold at such a price as to leave a fair profit on its manufacture. But up to the present time it has been so sold. If this should prove to be the case upon the large scale, and no inconvenience result to the inhabitants of this district from the alteration in the quality of their drinking-water, evidently the experiment will succeed. But it is important to observe that the system is, in this case, tried under very favourable circumstances. The quantity of water to be dealt with is small ; its chemical composition is as nearly uniform as can be. Yet, even under these circumstances, we hear that the water distributed varies, to a serious extent, in its quality. The process is, in fact, a delicate chemical operation ; and even if the lime be unequally burnt, it would require great practical knowledge and close attention to secure the uniform result so desirable in

works of this description. But if it were attempted to apply Dr. Clark's process to the immense bodies of water distributed by the great London Companies, the attempt would give rise to loss and disappointment. The chemical composition of river waters varies every day and every hour, and would thus render it necessary to vary the proportions of the ingredients which themselves are liable to vary in quality. We do not believe that it would ever be possible in practice to secure the skill, care, and attention necessary to overcome these difficulties; and therefore, although we look upon Dr. Clark's process as being a very elegant and philosophical application of chemical science to the wants of every-day life, we think that its use will be limited to small towns, or to large manufacturing establishments. For many of the latter we should think that it would be invaluable.

"The whole operations of the Plumstead, Woolwich, and Charlton Waterworks Company were executed under the directions of Mr. S. C. Homersham. In the three parishes of Plumstead, Woolwich, and Charlton, which this Company proposes to supply, there are at present about 7000 houses; and of these it is stated that about 2900 are already in receipt of the water. But it is generally understood that up to the present time the works have not been very remunerative."

CHAPTER X.

THE QUALITY AND SUPPLY OF METROPOLITAN WATERS.

PURE water, soft enough for ordinary domestic purposes, is a great luxury. But pure water in a scientific sense and microscopic point of view, is a luxury only within the reach of a few favoured districts and those individuals to whom money makes any kind of cooking easy. The question to be considered is, whether the water supplied to London under recent arrangements is not *scientifically* pure, but *practically* wholesome. Whether the filtered waters of the Thames, the Ravensbourne, and the Lea, or New River, which are now delivered from the main, clear, tasteless, and without odour, still contain anything really injurious to human life. Nature has done its part by the joint action of air and water in the full flowing volumes of the various streams, art has filtered away all solid impurities, cool dark reservoirs and covered mains have protected the fluid from the fermentation produced in stagnant water by light and heat. Is it still poisonous? Must we sink further capital in "cooking" the fifty or sixty million gallons, the daily supply of London, or must we double our mains for a separate water-drinking demand? or abandon the whole capital sunk in waterworks and plant, and seek perfection in some new, distant, and as yet undiscovered, region of pure soft springs?

Common sense, and the experience of the water-drinkers of the world, are in favour of our being content with water if it be clear, sweet, and odourless, without consulting those officers of health whose importance would be wofully diminished if they did not from time to time discover some *new "preventible disease."*

It is very alarming to some persons to be told that there are so many, say 10, 20, or 30 grains of organic matter in the 70,000 grains that compose a gallon of water; the very word "*organic*" is alarming. But what we really want to know is, whether, in this case, the stomach feels what the eye does not see? That is a question that most of the sanitary doctors avoid. They content themselves with discovering a new family of animalculæ, but do not tell us whether, like the mites in cheese, they may not be as harmless as tasteless. In a discussion, reported in the "*Society of Arts Journal*," 16th May, 1856, "*On the Means available to the Metropolis for the Supply of Water free from Hardness and from Organic Impurity*," the speeches of some of the medical men and chemists were so alarming that all the nervous persons who had drunk a glass of undistilled water that day might have gone home with a severe stomach-ache. But we must remember that it is the weakness of every calling to exaggerate its own importance, and that if we were to rule our lives by medical precautions, it would be difficult to find a scientifically wholesome dwelling, garment, or article of food; every article in common use and con-

sumption has been in turn condemned. But Dr. Hoffman, F.R.S., toward the close of the discussion, gave a certain degree of comfort to timid water-drinkers by stating that he "had been engaged in an extensive series of experiments, undertaken under the auspices of the President of the Board of Health [the Hon. Francis Cowper], embracing the waters of all the Companies, taken at regular intervals, so as to obtain an idea of their composition in different periods of the year, and that the results, which referred to the composition of the water during the winter months, had been highly satisfactory." And Mr. Beardmore, C.E., observed with a great deal of force, that "The supply of water to towns was always a geological and geographical question." "That it would be equally just and necessary that Manchester, or Carlisle, or Plymouth, should drink water containing three grains of carbonate of lime, as that towns on tertiary formations should consume water with four times as much of that salt." He also remarked that—

"In discussing the best means of affording a pure supply of water to the metropolis, due regard must be had to its position in the centre of a great basin entirely encircled by chalk hills, from which poured, in every direction, rivers composed of springs rising directly out of the chalk, the chief bulk and volume of which lay within 25 miles of St. Paul's. It was, no doubt, natural enough for people to cry out at the impurity of the Thames, seeing the state in which it flowed through the metropolis, owing to the sewerage proceedings of the past ten years; but it did not follow because such was the case below Teddington, that the chalk springs formed at any less the principal volume of the river above that point."

And in reference to a foolish and mistaken remark of Dr. Clark's, about the "dirty Lea," which is not dirty now, but blue and translucent, he said that—

"The entire body of that river was, for all practical purposes, pure spring water, and differed to no appreciable extent from the Chadwell spring, which formed only from one-sixth to one-eighth part of the present requirements of the New River Company's district. The river Lea was formed, to the extent of four-fifths of its entire volume, of chalk springs, rising either in its bed or within a few yards of its banks—the sole exception to the case being during times of flood, when artificial aid in the purification of waters was at all times more particularly required, and to which object the enormous expenditure of the Companies was largely devoted."

He also said, "he would neither encourage nor discourage the consideration of Dr. Clark's ingenious process, deeming it just one of those inventions which at present rested upon the debatable ground between theory and practice."

And here assuming, as we have a right to do until the contrary is proved by something better than the microscopic investigation of an irresponsible gentleman looking out for the berth or earning the salary of an officer of health, that the present improved supply of water is practically wholesome; and treating as very costly the operation of "cooking" by Clark's, or any other process, all water of London; and as absurd and ignorant, if not unprincipled, quackery, the idea of seeking the daily demands of 2,000,000 souls, or at least 50,000,000 gallons on

the gathering grounds of Bagshot, or any new sources,—we leave that part of the subject.

As to supply, recent alterations will make it daily instead of only twice or thrice a-week. So no one need drink his filtered water more than a day old.

That is an enormous advantage ; but certain parties, and notably the late Board of Health, insisted on the necessity of a **CONSTANT SUPPLY** for the use of the metropolis. **CONSTANT SUPPLY** means that the mains should always be charged at high-pressure and led into every house, so that for domestic use it would be unnecessary to have cisterns with two or three days' supply, but that all the water required might be had night or day, in any quantity, by turning a tap ; and as to street supply, that the mains, always at high pressure and provided with hydrants, would be ready for use in case of fire by simply screwing on a hose, and able to throw a stream to the top of the highest warehouse. *

That is the theory ; and about the abstract advantages of such a plan there cannot be a question. It was some years ago applied (with a gathering ground from a bed of silver-sand) to the village of Farnham, in Surrey, by an eminent and scientific agriculturist, Mr. J. M. Paine—one of Mr. Chadwick's witnesses, and, unlike most of them, an honest witness and respectable man. But there is a whole world of difference between a village in Surrey and old London sitting on her many hills with her two million of inhabitants claiming 30 gallons a-head, or sixty million gallons daily. The difficulties are mechanical and financial.

If London were, like New York in 1846, for the first time to be provided with an artificial water supply, there would be less difficulty in making mechanical arrangements for a constant supply; but at present London is not, as we before observed, a blank sheet of paper; hundreds of thousands of houses are provided with pipes, taps, and cisterns, every one of which would require alteration, and the greater number periodical inspection, in case of a change to "constant supply." And although that may be passed over as a mere trifle in a Blue-Book report, every one who remembers the havoc and demand for plumbers occasioned by the bursting of water taps after a long frost, will have some idea of the cost and condition of London if every water apparatus had to be refitted.

But another and more serious difficulty is a financial one. The metropolitan water costs money. It is not gathered in a mountain reservoir, and allowed to flow down to the houses supplied; every gallon is pumped up at a certain cost per gallon for coals, oil, and wear and tear of machinery. Mr. F. O. Ward (borrowing the idea from poor Smith of Deanston) once suggested that water should be pumped up by steam power, to be let out for turning the water-wheels of mechanics, which would be spending 2s. 6d. to earn 2d. The *constant supply* of a small town where the supply is unlimited, where the whole arrangements are new, where inspection is easy, where a supply at all is a novel luxury, where the police are looked upon with an awful reverence unknown in

the metropolis, where the Chairman of the Water Company is a great man, known to and knowing every one—there “constant supply” may be consistent with economy, and every inhabitant may be limited to his allowance of 15 or 25 or 30 gallons per day. But in great cities we have it on evidence that constant supply involves a waste of double the quantity used. The cook turns the tap to wash the greens, and leaves it running; the children turn the taps for fun; the gardener sticks a hose on, and deluges the garden in a different style from when he carried it by pailfulls; the housemaid washes the windows and door-steps in the same way; and the coachman uses a hogshead, instead of a bucketful, to wash a carriage. And for all this waste, in some shape or other, the public must pay.

Besides, the supply from the north-east of London is not unlimited; once establish waste, and the New River reservoirs might in a dry summer be so low, helped by taps running along miles of streets between, that when a fire broke out in some distant lofty spot, the high pressure would have been dribbled away, and the hydrants would fail to do their duty.

These hydrants, by-the-by, in every street would cost at first about £200,000, beside occasional repairs.

In reference to these difficulties of “waste,” we have some striking evidence from the United States as well as this country, from which we will give a few extracts. It must be noted that Mr. Chadwick calculated the needful supply of water at 15 gallons daily per head per day; that the Metropolis Water-

works have engaged to supply 25 gallons, and could supply 30 gallons. We will begin with New York. There the waterworks have been recently executed under singular advantages of situation, as one comprehensive and most magnificent whole, with no old works or customs to obstruct the engineers. The supply is derived from a mountain reservoir descending by gravitation without pumping.

From 1848 to 1854 the Croton Aqueduct Board have filled pages of their annual reports with protests and warnings of the cost and danger of the constant waste of water. In 1850, they say:—

“The most unremitting and zealous exertions of the department to abate the intolerable waste of water have produced an effect scarcely perceptible to the public eye.”

“It frequently happens, on Saturdays especially, when zealous housewifery puts every street washer in requisition (whether necessary or not), that the reservoir is drawn down to half its capacity, equal to 10,000,000 of gallons more, and making an aggregate of 40,000,000 of gallons for a single day's consumption, in a population (within the water district) of not more than 430,000 persons, or 90 gallons to each individual.”

In 1853, the population having increased by twenty thousand, the daily water supply is reported to still reach “90 gallons for each inhabitant;” and

“By the middle of June the two reservoirs had been drawn down some feet and were daily falling; immediate action was required, and all the clerks and *employés* of the Department were each directed to report every violation of these ordinances and rules, that the fines and penalties attaching to the offence might be imposed and collected.”

“In 1854, the Board regret that they are compelled every year to allude to the unwarrantable waste of an element so

valuable and indispensable to the health and comfort of their fellow citizens. Notwithstanding every effort has been made by the Department to check the waste of water, they have every reason to believe that a very great proportion of the water placed at the disposal of the consumers is used for no valuable or practical purpose."

And in 1855 the same regrets are repeated.

Turning from New York to Boston, one of the most educated and intelligent communities in the world, we find that after having estimated in 1844, before the works were completed, the probable demand at 30 gallons per head, in 1851 we find the Cochituate Water Board reporting that the

"Average for the year is more than double the quantity that was originally estimated to be a sufficient supply for all the wants of the present number of inhabitants in the City. Indeed, it is nearly equal to the quantity which it was supposed would be required for a population of 250,000, and on some days it has far exceeded that amount:"

—the population in that year being about 125,000, and, on an average, above the condition in life and education of one-third the population of London.

In 1852, the same Board report the consumption under constant supply at 58 gallons per head.

In 1853, they report the consumption at 55 gallons daily. They add—

"Since the month of September the excess of the consumption over the last year has been continually increasing, so that, during the month of December, it amounted to 2,032,582 gallons daily—the daily average for the month being 9,228,400 gallons. On the 25th of January, when the cold became intense for twenty-four hours, the consumption was 11,600,000. On the 26th it was 13,100,000. On the 28th, and also on the

29th, it was upwards of 14,000,000 ; and the average for the month has been 10,800,000. The consequence has been, that the reservoirs on Beacon Hill and at South Boston were drained, and that at East Boston reduced at one time to 3 feet 6 inches. There was an entire failure of supply to many houses on Mount Vernon, and also on Fort Hill, and the higher parts of Broadway, South Boston."

So much for the extravagance of constant supply, when dealing wholesale with the varied inhabitants of great cities.

Returning to England, we have examples of the difficulties of the constant supply system in a series of towns where the waterworks have been executed under the supervision and on the plans of Mr. Chadwick's Board of Health, by his favourite engineers. For instance, at *Rugby*—

"The water is laid on upon the principle of constant supply, and has been exhausted three or four times by the carelessness of persons leaving the taps open. A foreman goes round every morning to examine the condition of the water-taps and drain inlets ; and this strict supervision is found to be of the utmost importance to the successful operation of these works."

"At *Sandgate*, the supply of water is upon what is termed the 'constant supply' system ; but there has been so much waste from leaving the taps open, that the surveyor has been obliged to turn off the water from the mains every night for some months past, to give a sufficient supply during the day-time, so that during the night the houses, having no cisterns, are left entirely without water, instead of having a 'constant supply.'

"The water is soft and of good quality, but in draining from the sand bed it carries with it a large quantity of sand, which collects in the reservoirs to the depth of about five inches in six months. The reservoirs are generally cleared out twice in the year. This sand also collects in the water mains, and when the water is first turned on, or is drawn off in large quan-

tities for watering the roads, it carries with it the sand, and renders its delivery turbid and impure, and the occupiers of the better houses generally filter this water themselves before drinking it."

St. Thomas's, Exeter.—"The Exeter Waterworks Company provide St. Thomas's with water upon the system of constant supply. It is obtained from the river Pynes, a branch of the Exe and Culm, about four miles above Exeter.

"The Superintendent under the Engineer of the Company states that the supply of water from the Exeter Works to the district of St. Thomas, as near as it can be ascertained, usually *exceeds an average of 120 gallons per house per diem.*"

Thus we find that wherever "*gathering grounds*" have been relied on, the supply has fallen short; and wherever the supply has been unlimited, the waste has been enormous.

At the same time, there is no doubt that, if the metropolis is prepared to pay for 60 to 90 gallons per head per day, it would be a great luxury—but it must be paid for.

In any case there are many instances in which cisterns could not safely be dispensed with.

The public, instead of relying on some hydraulic Hercules, cannot be too strongly impressed with the necessity of having their water-drinking cisterns covered; of keeping them clean and cool; and of filtering their water whenever it has to remain any time in a cistern, after passing from the main.

Every court and alley of London ought to have the means of getting pure drinking-water; but, as water pumped and filtered costs money, the Companies are as much entitled to be paid as the butcher for beef,

the brewer for beer, or a sanitary reformer his pension for past agitation. And the experience of Government Boards abroad and at home has invariably proved them, after the first display at starting, more expensive, more dilatory in effecting improvements than private Companies, and perfectly above the reach of any remonstrance less serious than a violent political demonstration.

CHAPTER XI.

SUMMARY OF EVIDENCE.

IN the preceding pages, we have recorded a long list of failures in the works executed under the direction of the late Board of Health. We have shown, on evidence which cannot be contradicted, that the earthenware pipe system, applied *officially*, has not realised the benefits promised; that is to say, it has not been efficient or economical; but that pipes applied in moderation, and not despotically, combined with brick sewers of sufficient capacity, as in the City of London, have been both efficient and economical. We have shown, that the Board of Health system of relying for a "constant water supply on rainfall" collected in gathering grounds has failed signally; and that (although the benefits of a constant supply of pure soft water are as undeniable as the defects in quality of London water in 1850) the quality would not compensate for the short supply which would be inevitable in a dry summer; that although a number of towns had been compelled or induced to go to considerable extra expenses, in

order to build sewageometers, and to apply sewage to agricultural purposes, not one example can be found of a revenue of any importance reaped from this source, but that several vile nuisances have been created.

We have shown that "the Reports of Trial Works Committee" and evidence, which have been officially quoted and circulated by Mr. Chadwick's Board of Health, were absurd as scientific inquiries, and fraudulent as matters of evidence.

Between 1848, the year in which the General Board of Health was formed, and 1853, a large body of practical experience was available for the use of those who started in 1848, unread in hydraulic science, and inexperienced in works, to correct their first vague notions on sanitary subjects and sanitary works.

Men of candour—men of common-sense business habits—men of a scientific and practical turn of mind, would have learned something, even if they knew nothing when they began, from this five years of experience. But in Board of Health documents we have startling proof that the legal, commissioner, official pensioner order of mind, learns nothing from experience; like Charles X., of whom it was said he returned to France after his long exile, "having learned nothing and forgotten nothing." In that respect Mr. Edwin Chadwick is a sort of Bourbon, for his parrot-like reciting, in 1856, at a Meeting of the Royal Agricultural Society, the phrases that gave him his seat at the Board he devised in 1848.

In August, 1853, Mr. Edwin Chadwick and Dr.

Southwood Smith * took the extraordinary course of addressing a letter to the Home Secretary, on the subject of the drainage of the metropolis; a subject in which they had no more right to interfere, than in the Ordnance or the ship-building of the navy yards. For reasons which may be imagined, Lord Shaftesbury did not join so as to make the communication official; and therefore the two gentlemen wrote, as they say, in their capacity as Commissioners of one Sanitary Commission which had been dissolved, and of another, the Metropolitan Commission of Sewers, from which they had been ejected for incompetence.

This public (private) letter was a criticism by a lawyer and a doctor, on the works and plans of the most eminent engineers under the direction of a Commission which included [men whose business and practical experience far exceeded any qualification that could be claimed by the legal or lordly amateurs of the Board of Health. But it is not necessary to recur to these plans; we only refer to this letter to pick out a few specimens of the reckless statements of Mr. Chadwick and his obedient friend.

They begin by quoting from the Metropolitan Sanitary Report, praise of "principles of construction and management of improved works," that is to say, like those at Croydon and Sandgate, Carrier Street, and Kennington, Southampton and Dover; and then they go on to complain that "Trial Works were

* It is really lamentable that any circumstances should have made a man of such talents and acquirements as Dr. Southwood Smith harness himself to the wheels of Mr. Chadwick's liquid manure chariot.

conducted " (they do not say at a cost of £7180), "and portions of improved work laid down," by the first Metropolitan Commission, and that "a further extension of Trial Works had been urged" (by Chadwick and Co.), "but that all further investigation had been abandoned;" that "no account had been taken of the arrangements made (by the first Commission) for considering the under drainage of the marshy districts bordering on the metropolis, or for the application of the sewage to agricultural purposes."

This was rather audacious, considering, as we have shown, what the utter worthlessness of the Trial Works cost, and considering, too, the notorious failures of the Board of Health in their sewers and agricultural manure plans; but better follows. The lawyer and doctor do not approve "of the evidence given by the consulting engineers of the Commissioners before the Committee on the Great London Drainage Bill." That being the case, it is to be regretted that Mr. Chadwick did not offer himself as a witness; but he is too cunning to place himself in a position to be cross-examined. They proceed to find fault with the cost of the Victoria Sewer, that extra cost being due entirely to the plans of Mr. Chadwick's friend and much-quoted witness, Captain Veitch. But if excess of estimates is a fatal error, what shall we say of Board of Health official inspectors, whose works, before they will work, in every instance exceed the estimate, and have never been known, except in the instance of

one village, of a single street (Tottenham), to answer their intended purpose?

And growing warmer, the lawyer and doctor kindly offer, on the evidence of their stereotyped witnesses, "The Trial Works," to sewer and drain Westminster for a mere trifle. And lest the evidence of the "Clerks of Works," who constitute "the Trial Works" evidence, should not be enough, they call amiable and classical Lord Morpeth as a witness, and quote the speech and estimate which Mr. Chadwick prepared for him in 1847, to show that Sir W. Cubitt and Mr. Stephenson do not understand their business, and are not to be believed on their oaths.

The engineers of the Metropolitan and City Commission, who proved that the self-cleansing pipe sewers laid down by Mr. Chadwick choked up, are accused of "misleading," and "suppressing" extenuating circumstances.

The volunteer lawyer and doctor are of opinion, from the "detailed estimates of *trustworthy officers*," (the Clerks of the Works who made a Quart go into a Pint Measure, or the Engineers who failed at Sandgate, Dover, and Southampton?) that all London could be drained *de novo*, "with sewers quite free from deposit" (these must be quite unlike the ordinary run of Board of Health work), for, "say at present prices, one million sterling!"

This generous offer sounds extremely like advertisements, or rather tickets, to be seen in certain shops, such as "This fine gold chain, only 8s. 6d.;" or "Complete suit of fine Saxony cloth at £2 2s.; usual price, £6;" but we should like to have the names of

the "trustworthy officers." Can it be Mr. Lee, the liquid-manure reporter, the inveigler of Mr. Hawkesley's clerk ; or Mr. Ranger, who borrows a water-works plan ; or Mr. Rammell, whose sewers are not quite self-cleansing ; or the invaluable Medworth, author of the "Live Rat Experiment," whose hydraulic science has since settled in beer ? These gentlemen, like the lawyer and doctor, are always ready for a cheap job, and they are not alone in that praiseworthy notion. There are plenty of Bob Sawyers ready to perform the most difficult operations at 5s. a-piece.

It is rather curious that in 1853, a year before the expiration of the Board of Health Act, our amateur engineers do not refer to any of the towns where their "improved works" are in operation, but to Woolwich, which was *not*, but *was about to be*, blessed by the Board of Health system.

The conclusion of this volunteer letter has a paragraph, which is a brilliant example of modest assurance. We find that the lawyer and doctor "objected to the Consolidated Sewers Commission being entrusted with the distribution of rates over long periods of time, *without the provision of competent and responsible examination*," which means that what Messrs. Haywood and Bazalgette plan, and Stephenson and Cubitt approve, ought to be submitted to Mr. Chadwick, and Mr. Rammell or Ranger, or Lee or Austen, author of the great cesspool and steam-sump system.

After this private exposition of what are called "the erroneous principles" of engineers, whose

works, however, do not require official Blue Books to defend them, the "Report of the General Board of Health" on their administration "from 1848 to 1854," is, as might have been expected, a song of triumph throughout, except when, at fit periods, denunciations of the noxious principles and erroneous practices of engineers are introduced by way of contrast.

It is not necessary to travel through every paragraph of this reproduction of the report of the lawyer and doctor, lord and plumber's, in 1847. It was a last desperate effort to retain their position, their snug berths, by asking for more power.

The statements are stale enough; "what is new is not true, and what is true is not new." But the careful suppression of information that ought to have been given is the most remarkable feature of this report, which in fact is not a report at all, but a brief "for the defendant Edwin Chadwick, on his trial for bribery, intimidation, incompetence, and general abuse of power."

The report vaguely mentions the great scheme for placing the funerals and cemeteries entirely in the hands of the Board of Health, which broke down because the House of Commons very wisely refused to vote funds for so gross a job. The report does not allude to the thousands of pounds which the Board of Health was obliged to pay for Mr. Chadwick's rash purchase of cemeteries.

The next paragraph is occupied with the Board's report on the water supply of the metropolis in 1850—a report stuffed with evidence from "Trial Works

witnesses," and others equally untrustworthy, practically and scientifically ; but no reference is made to the now well-known fact, that if London water supply had depended on the Board's plan of rainfall gathering grounds, instead of, as at present, on rivers, the whole metropolis would have been entirely without any water supply at all for at least twelve months. At the villages of Sandgate and Rugby, the people had their old pumps and wells, in spite of the official engineer.

When the report has to mention the Board of Health works of water supply and drainage, a few names here and a few there are given, no business-like summary of the state of each town under the care of the Board and the progress of the works, but a sort of lump statement, affording the least possible room for investigation or contradiction : in fact, a studious obscurity is thrown over the principal works of the Board ; one bold mis-statement being hazarded, viz. that, with the exception of Croydon, all the works are working satisfactorily.

Then comes—what?—paraphrasing an expression applied to one who was not a man of reports, but a man of action, "a truly Chadwickian touch," admirably adapted to deceive a hasty reader of Blue Books. "Supposing," says the report, "the cost of the execution of plans for 57 towns, not yet placed on the Procrustean* bed of the Board of Health, be at the

* Procrustes, according to Greek Mythology, was a robber who seized on travellers and laid them on an iron bed—if they were too long, he lopped their legs off to the exact size ; if they were too short, he applied a screw, and stretched them out. Probably the word robber is a mis-translation ; a Commissioner would be the more correct name.

same rate as the 31 towns, for which sanctions have been given, there will be required £4,800,000, augmented in consequence of the rise in the price of labour and materials to £6,000,000, that is to say, $2\frac{1}{2}d.$ per week per house."

Now this sounds well to a hasty reader, except the jump to £6,000,000 ; but on close examination it is an estimate founded on an estimate without any thermometer of proof.

It is as if the captain of a line-of-battle ship, whose men's clothes cost £4 a-head, entered into a contract with Mordecai, to clothe them all round at £1 a-head, and then published a report estimating the whole navy at 50,000 men, and assuming that by employing Mordecai's shoddy garments £150,000 might be saved.

The estimates sanctioned by the Board have always been exceeded by from £50 to £200 per cent. in repairs alone.

In this report we have many references to witnesses, but few names are mentioned, the writers relying on the "official authority" for supporting any kind of statement.

We may pass over the praises of "the improved system," and the unfinished works, like Rugby, Southampton, Dover, Salisbury, which have since failed, quoted as specimens of success in water supply.

About sewage manure, after ten years, they are still hopeful ; they talk of ten towns where "inoffensive and beneficial distribution by the flexible pipes and jets may be early anticipated ;" but they name no

names, so we cannot go in 1856 and see how, after another three years, Mr. Chadwick's pipes of liquid gold are getting on.

After a string of the "self-cleansing" assertions, as, for instance, "that it would be cheaper and more healthy to take up pipe sewers every four or five years, than to build brick sewers," although, unfortunately, half the pipe sewers, as laid by the Board of Health, will not last even a year without relaying; Lambeth Square is quoted as a triumph of the improved system, all mention of the large brick sewer that drains it, and the repeated choking up of house drains, being omitted; but Lambeth Square is a standing dish at the Chadwickian Board.

The most flagrant specimen of tabular falsehood is to be found at p. 40, where the reporters profess to give a comparison between the cost of the two systems. The pipes of Southampton, for instance, assumed to be successful, are put down at the lowest figure; the brick sewers at the highest, although in many instances the scientific and practical engineers would, as a matter of course, have used pipes in their proper place, combined with brick mains if needful. And the mis-statement is the more discreditable, because at least four of their principal instances have failed, and others are mere unexecuted estimates. The fact that brick sewers drain damp soils, an important advantage, is, of course, unnoticed.

The figure falsehood is crowned by a comparison between the cost of drains in the metropolis, and in such towns and villages as Rugby, Tottenham, and

St. Thomas's, Exeter. But we have dissected these model towns in our chapter on Board of Health.

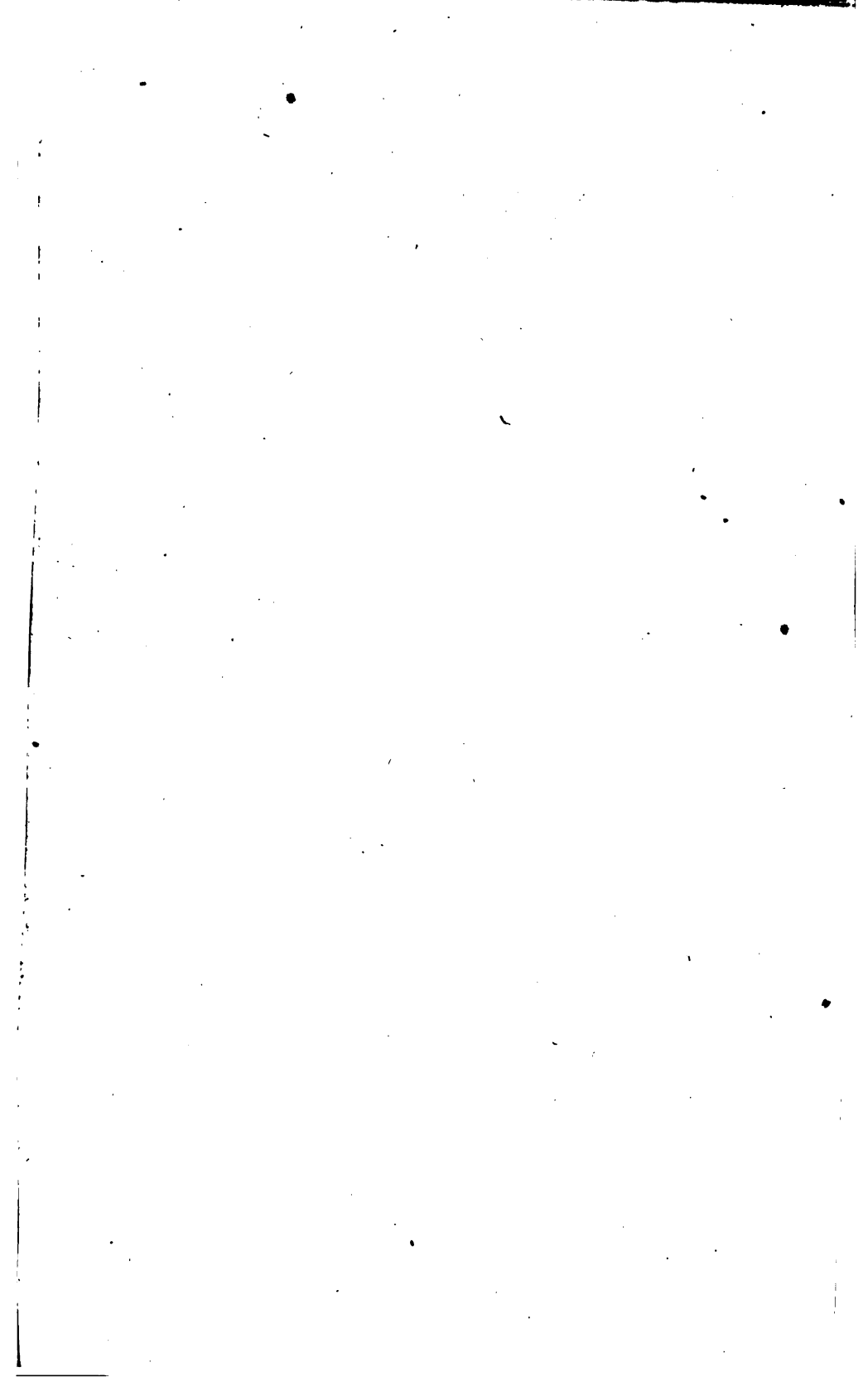
It is unnecessary to proceed further with this most mendacious document, which was penned and circulated extensively at the public expense, for the purpose of keeping up a Board of Commissioners, at the cost of upwards of £30,000 a-year, with patronage to the extent of many hundreds of thousands a-year — a Board, which desired to centre in its own hands the control of the whole local government of England and of the metropolis, including water supply, gas, funerals, and burials, and aimed at extinguishing all progress in engineering works, by forcing on all places, under all circumstances, one fixed, stereotyped, and empirical system, to be executed by humble officials, under the absolute despotism of an ambitious, unscrupulous, industrious, persevering, half-educated lawyer.

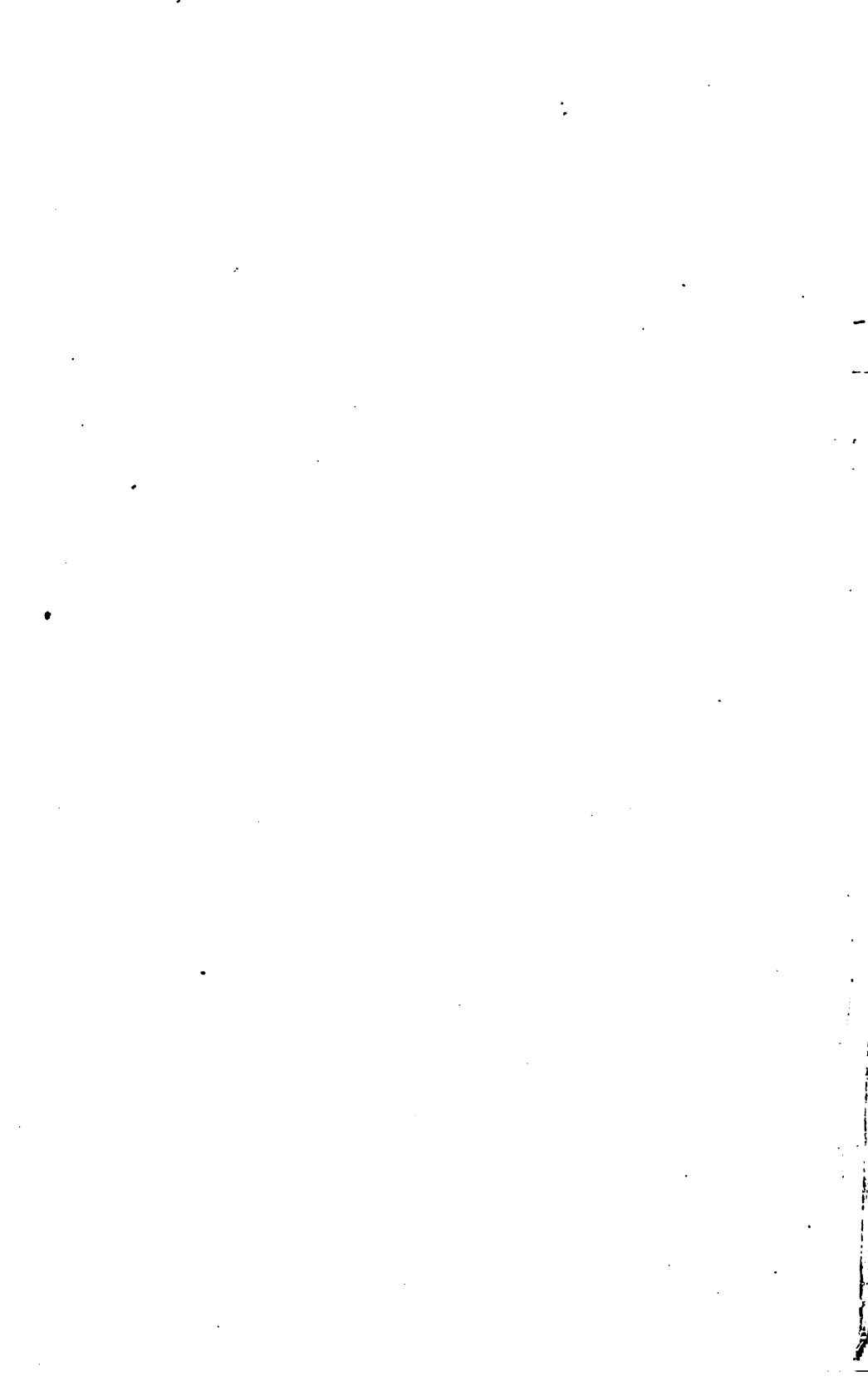
The scheme was temporarily defeated, and the Board of Health only renewed for one year; but the schemes headed ostensibly by Mr. F. O. Ward, and counselled by Mr. Edwin Chadwick, are cunningly preparing for a second attempt to establish a social despotism. They are keeping the Board of Health alive by giving it the administration of small Acts of Parliament, which are quietly pushed through every session by the Ebringtons and their tail. The conspirators found their future hopes on the failure of the Metropolitan Improvement Act. They hope that numbers of the District Boards may prove too unwieldy for work. The defeat of these ardent seekers

of office, power, patronage, and pensions, will depend on the good sense of metropolitan constituents and representatives.

In the preceding pages we have used some harsh phrases to Messrs. Chadwick, Ward, and Company ; but we believe we have justified every phrase by evidence ; gentlemen and noblemen who impute "falsehood and suppression of truth," the "use of false measures and unjust balances," corrupt attempts to increase expenses, in order "to increase professional fees," and other charges of the same character, to the engineers, who refuse to be the slaves of an empirical system, have no claim to rose-water treatment. They have spent millions in miserable failures. They must now hear the truth.

"Certain entomological creatures," says Sydney Smith, "if they could speak, would object to the small-tooth comb." Finger and thumb, precipitate powder, anything you please, except the comb ; "but no attention must be paid to such protests," even though a Lord Ebrington call them cruel, and malignant. "They must be caught, cracked, and killed in the manner most convenient."





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